Instruction Report ITL-96-2
June 1996

US Army Corps
of Engineers
Waterways Experiment
Station

Computer-Aided Structural Engineering (CASE) Project

Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 5
Scheme C

by *David Wickersheimer, Carl Roth, Gene McDermott*
Wickersheimer Engineers, Inc.

WES

Approved For Public Release; Distribution Is Unlimited

19960827 099

DTIC QUALITY INSPECTED 1

Prepared for Headquarters, U.S. Army Corps of Engineers

This program belongs to Wickersheimer Engineers, Inc. and is furnished by Wickersheimer Engineers to the Government for unlimited distribution to recipients within Government Agencies. Although an extensive effort has been made to supply the recipient with an accurate structural design program and manual, Wickersheimer Engineers does not provide any warranties, either expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability of the program for structural design projects.

© COPYRIGHT 1988-1994. Wickersheimer Engineers, Inc.

ALL RIGHTS RESERVED.

The program described in this manual is protected by United States Copyright Law. Therefore, the recipient may not copy or duplicate the program except for the sole purpose of backing it up to prevent loss.

PRINTED ON RECYCLED PAPER

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

Computer-Aided Structural
Engineering (CASE) Project

Instruction Report ITL-96-2
June 1996

Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 5
Scheme C

by David Wickersheimer, Carl Roth, Gene McDermott

Wickersheimer Engineers, Inc.
821 South Neil Street
Champaign, IL 61820

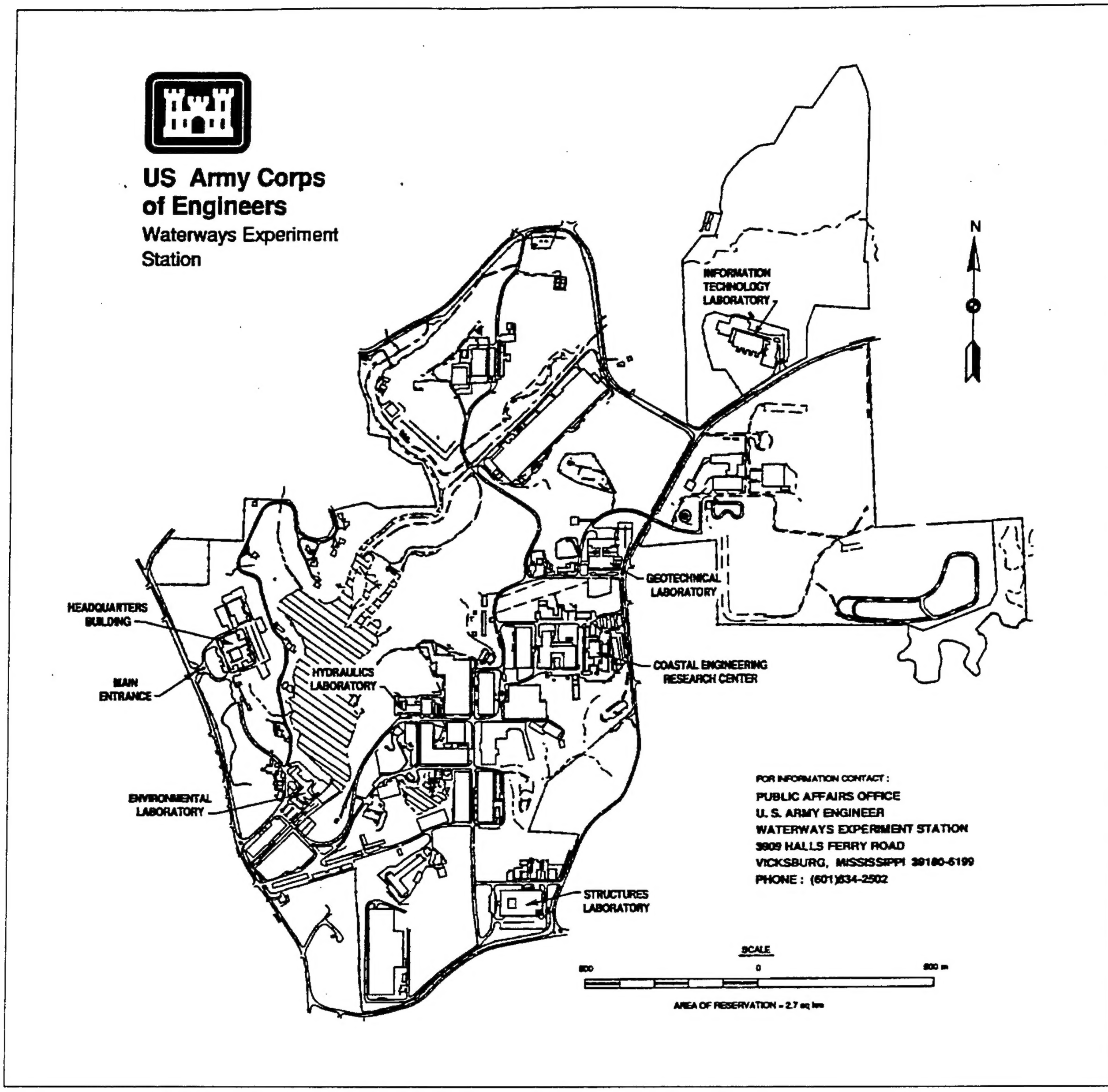
Report 5 of a series

Approved for public release; distribution is unlimited

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

Monitored by U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

Under Work Unit AT40-CA-001



Waterways Experiment Station Cataloging-in-Publication Data

Wickersheimer, David.

Computer-Aided Structural Modeling (CASM) : version 6.00. Report 5, Scheme C / by David Wickersheimer, Carl Roth, Gene McDermott ; prepared for U.S. Army Corps of Engineers ; monitored by U.S. Army Engineer Waterways Experiment Station.

202 p. : ill. ; 28 cm. -- (Instruction report ; ITL-96-2 rept.5)

Includes bibliographic references.

Report 5 of a series.

1. Structural engineering -- Computer programs. 2. Computer-aided engineering. 3. Structural analysis (Engineering) -- Computer programs. 4. Loads (Forces) -- Data processing. I. Roth, Carl. II. McDermott, Gene. III. United States. Army. Corps of Engineers. IV. U.S. Army Engineer Waterways Experiment Station. V. Information Technology Laboratory (U.S. Army Engineer Waterways Experiment Station) VI. Computer-aided Structural Engineering Project. VII. Title. VIII. Series: Instruction report (U.S. Army Engineer Waterways Experiment Station) ; ITL-96-2 rept.5.

TA7 W34i no.ITL-96-2 rept.5

PREFACE

This report describes the computer program CASM, which is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics, to describe the structural framing scheme for shear walls using monolithic concrete for a two-story portion, steel for the lower roof portion, and lateral load resistance. Funds for the development of this program and publication of this user's guide were provided to the Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

Specifications for the program were provided by members of the Building Systems Task Group of the CASE Project. The following were members of the task group during program development:

Mr. Dan Reynolds, U.S. Army Engineer (USAE) District, Sacramento (Chairman)

Ms. Anjana Chudgar, USAE Division, Ohio River

Mr. Pete Rossbach, USAE District, Baltimore

Mr. Dave Smith, USAE District, Omaha

Mr. Mark Burkholder, USAE District, Tulsa

Mr. Jerry Maurseth, USAE District, Portland

Mr. Chris Merrill, WES

Mr. Michael Pace, WES

The computer program and report were written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

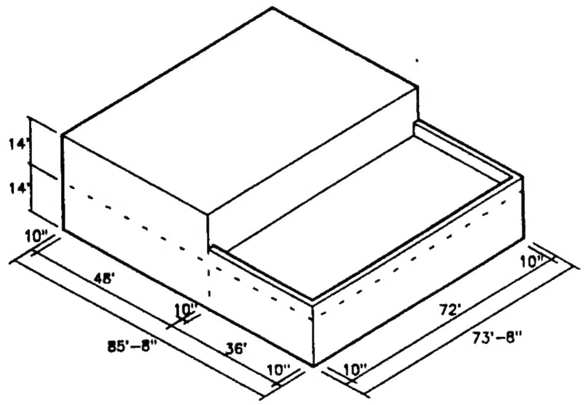
The work was monitored at WES by Mr. Michael E. Pace and Mr. Chris Merrill, Computer-Aided Engineering Division (CAED), under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; Dr. Reed Mosher, Chief, CAED; Mr. Timothy Ables, Assistant Director, ITL; and Dr. N. Radhakrishnan, Director, ITL. Mr. Donald Dressler was the original HQUSACE point of contact, and Mr. Charlie Gutberlet is the present technical monitor.

Dr. Robert W. Whalin is Director of WES. COL Bruce K. Howard, EN, is Commander.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

Table of Contents

Project Description



This 1 and 2 story project is to provide approximately 9,500 gross square feet of office space for one of two possible sites:

(a) Charleston, South Carolina

(b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

1. The 36' x 72' space on the first level shall be column free for open office planning.

2. The 48' x 72' first and second floor areas shall provide 24' square bays.

3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.

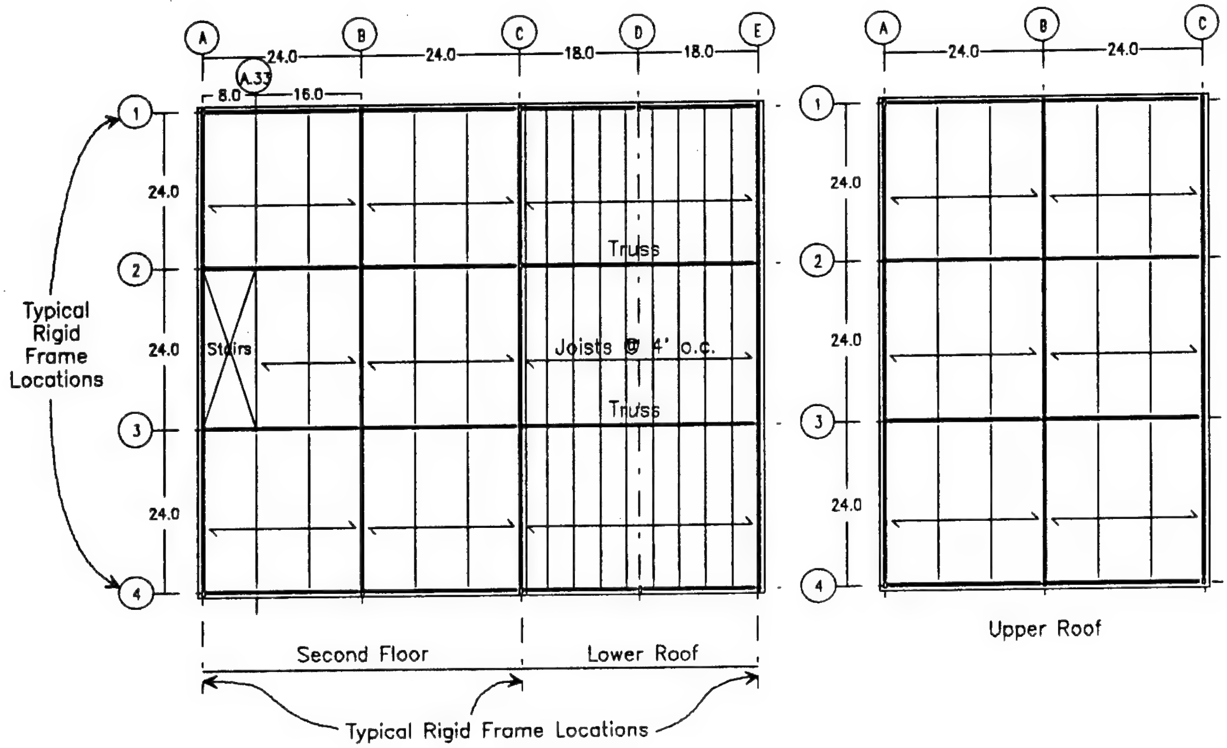
4. The second floor occupancy live loads located on the plan are:

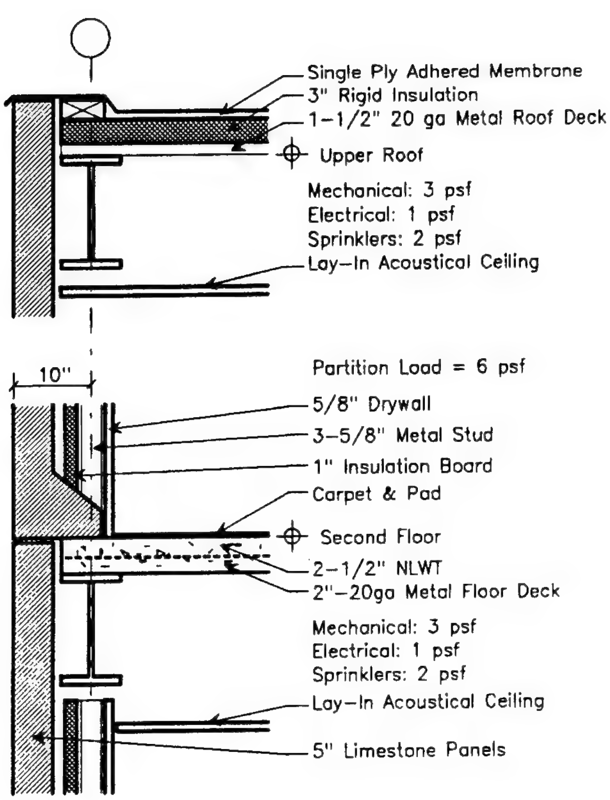
Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf

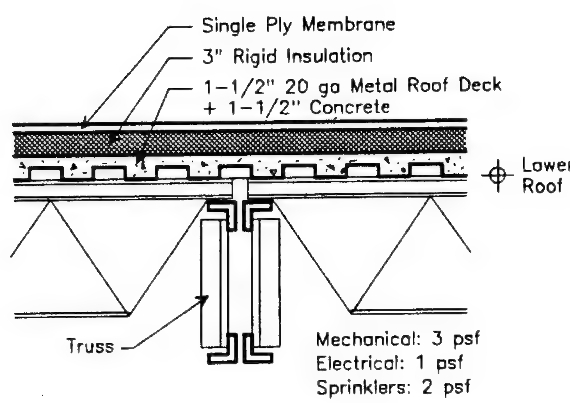
5. Structural framing schemes to be designed and compared shall be as follows:

Scheme A:	All steel, non-composite, lateral load resistance = rigid frames.
Scheme B:	All steel, composite, lateral load resistance = X braced frames.
Scheme C:	Monolithic concrete for two story portion, steel for lower roof portion, lateral load resistance = shear walls.

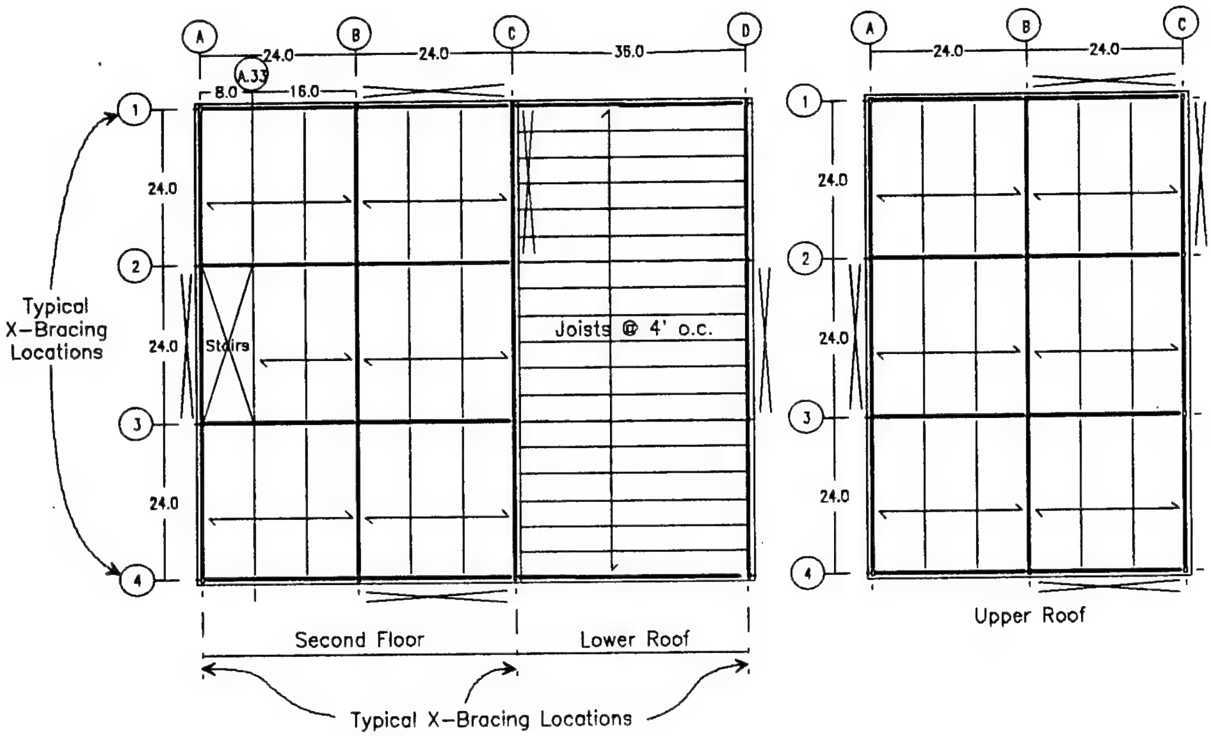
Scheme A

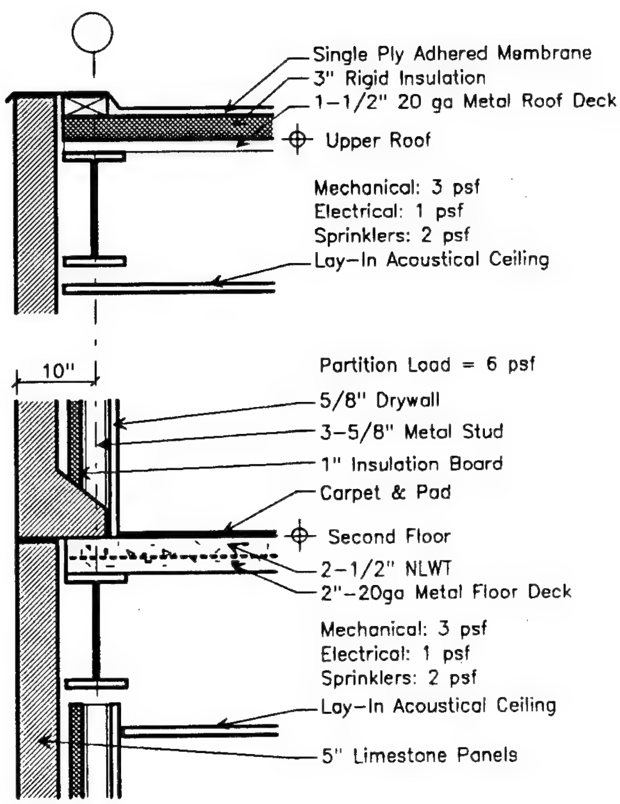

A
B
C
D
E
24.0
24.0
18.0
18.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical
Rigid
Frame
Locations
Stairs
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Typical Rigid Frame Locations
A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof

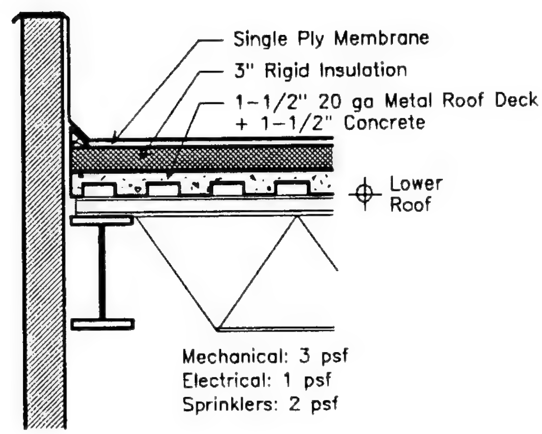

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower
Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

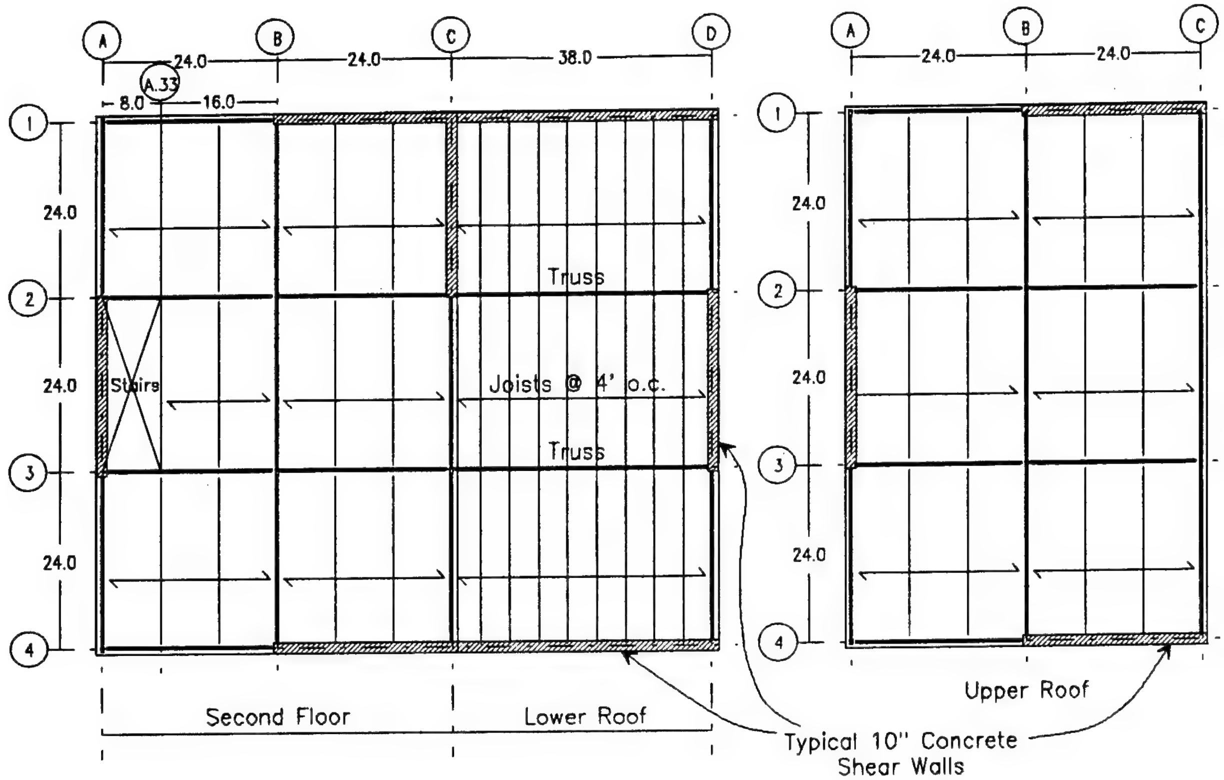
Scheme B


A
B
C
D
24.0
24.0
36.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical
X–Bracing
Locations
Stairs
Joists @ 4' o.c.
Second Floor
Lower Roof
Typical X–Bracing Locations
A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof

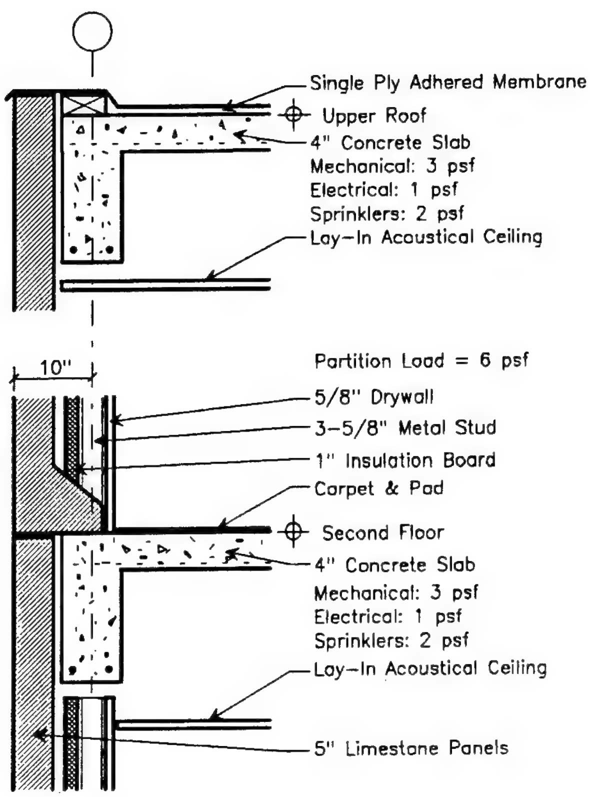

Single Ply Adhered Membrane
3" Rigid Insulation
1–1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay–In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3–5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2–1/2" NLWT
2"–20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay–In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1–1/2" 20 ga Metal Roof Deck
+ 1–1/2" Concrete
Lower
Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

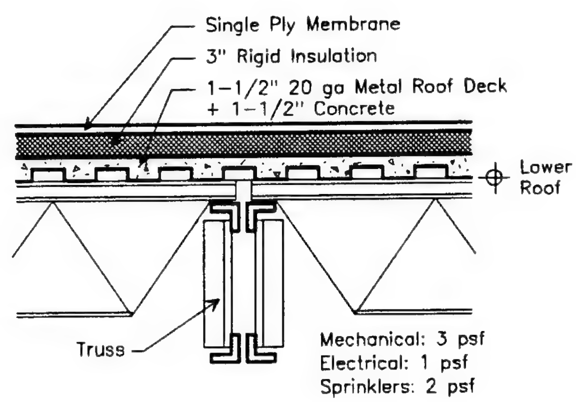
Scheme C



A
B
C
D
24.0
24.0
38.0
A.33
8.0
16.0
1
2
3
4
Truss
Stairs
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Upper Roof
Typical 10" Concrete Shear Walls



Single Ply Adhered Membrane
Upper Roof
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels



Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

6. The typical exterior envelope consists of 5" limestone panels, 1" rigid insulation, 3-5/8" metal studs, and 5/8" drywall.

7. Window and door openings are uniformly distributed to all elevations.

8. Load Assumptions:

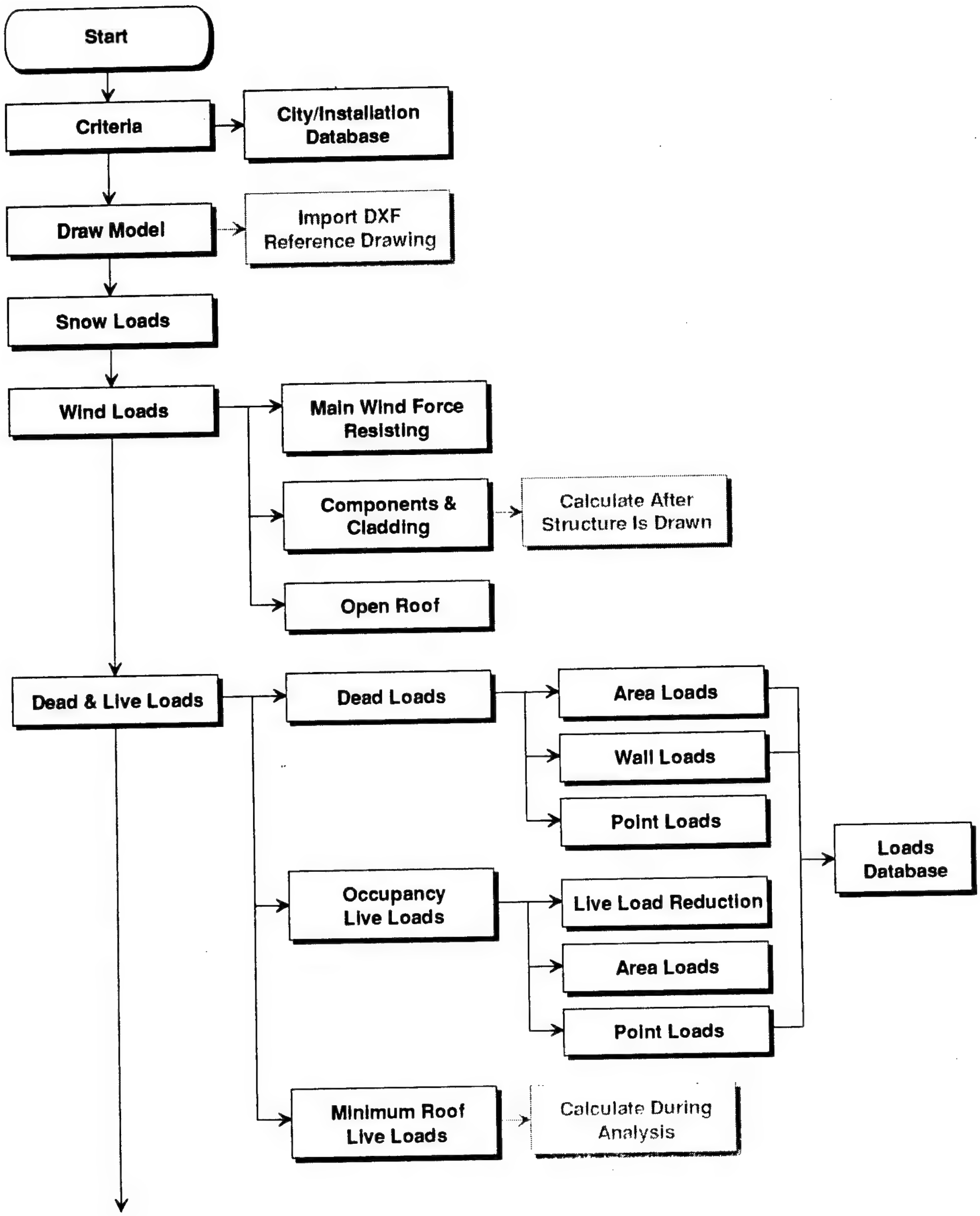
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

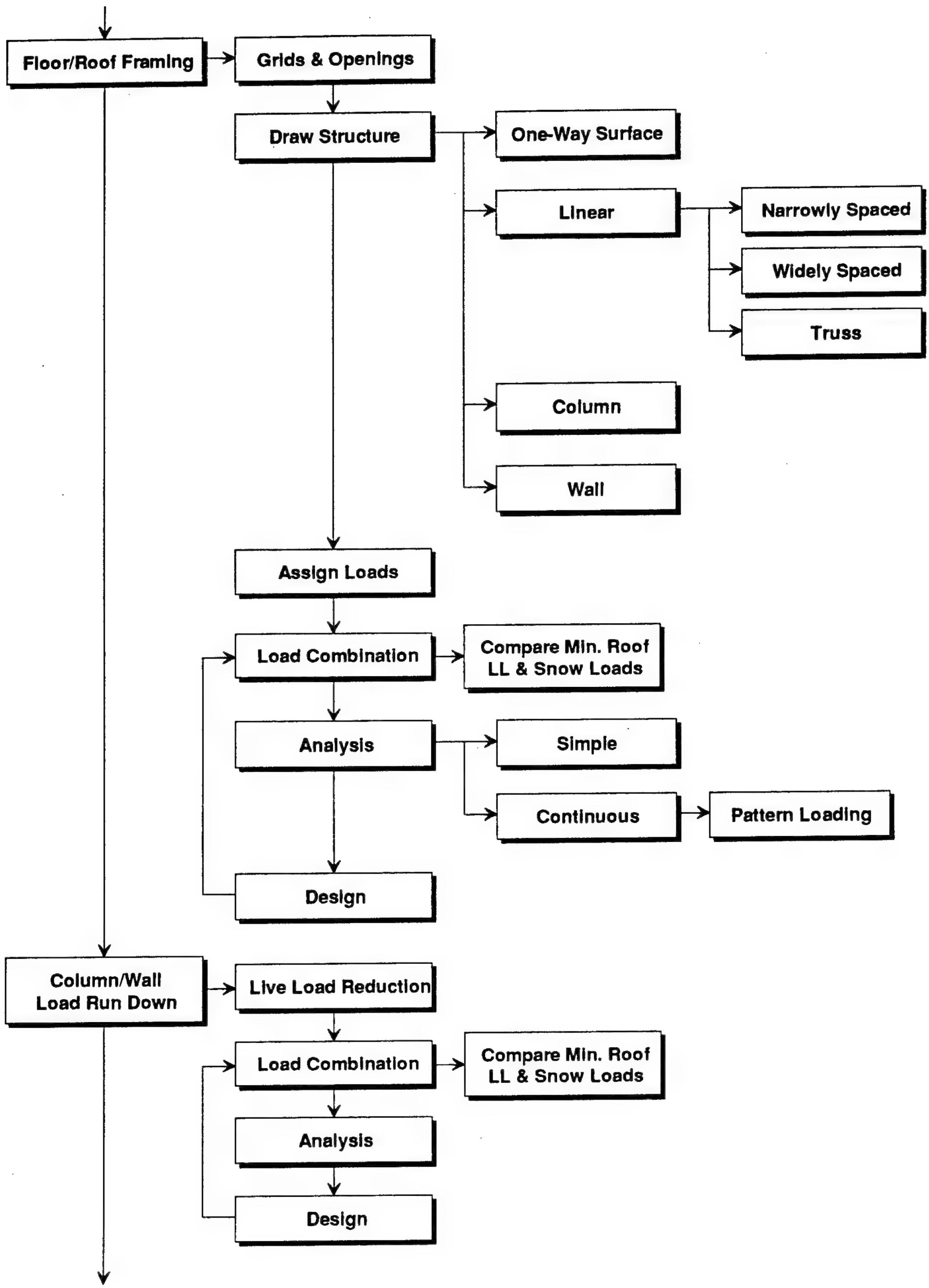
9. Material Assumptions:

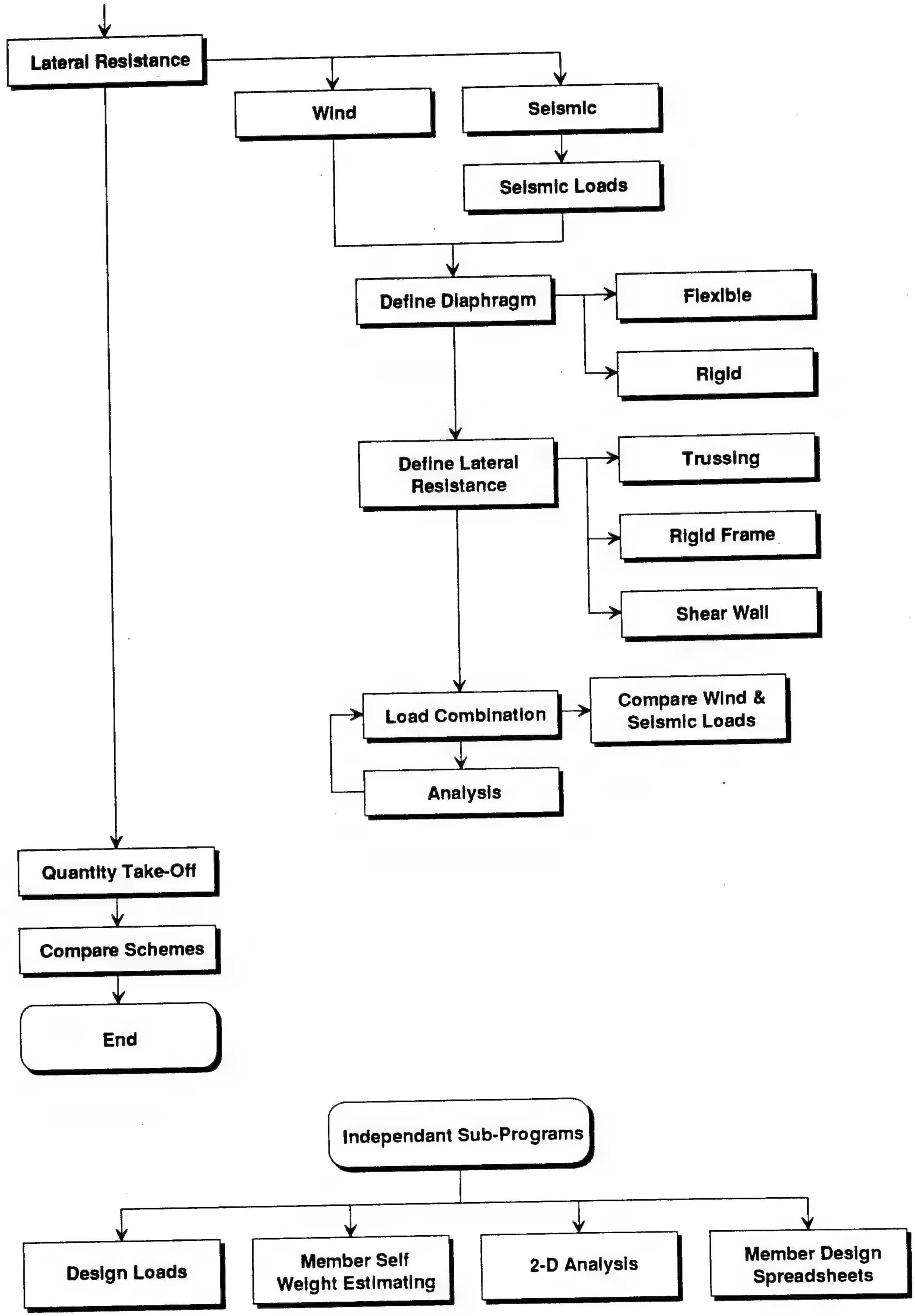
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

10. Fire resistance rating shall be achieved by a wet sprinkler system.

Computer Aided Structural Modeling




Floor/Roof Framing
Grids & Openings
Draw Structure
One-Way Surface
Linear
Narrowly Spaced
Widely Spaced
Truss
Column
Wall
Assign Loads
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Simple
Continuous
Pattern Loading
Design
Column/Wall Load Run Down
Live Load Reduction
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Design


Lateral Resistance
Wind
Seismic
Seismic Loads
Define Diaphragm
Flexible
Rigid
Define Lateral Resistance
Trussing
Rigid Frame
Shear Wall
Load Combination
Compare Wind & Seismic Loads
Analysis
Quantity Take-Off
Compare Schemes
End
Independant Sub-Programs
Design Loads
Member Self Weight Estimating
2-D Analysis
Member Design Spreadsheets

Criteria

Start

↓

Use Criteria Menu

↓

Project → Project Data → City/Installation → Select Radford AAP From List

Project Data

Project Name:	Office Building - Scheme C
City/Installation:	Radford AAP
Country:	USA
State:	VA
County:	Pulaski
Design Load:	TM 5-809-1 1992
Building Code:	BOCA
Seismic Code:	TM 5-809-10 1992
Elevation Above Sea Level:	3300 ft
No. Of Stories:	2
Floor Area:	9504 sq ft
Occupancy:	Use Group B
Type Const:	3A
Seismic Lateral Load Resistance	
N-S System:	Blank
E-W System:	Blank

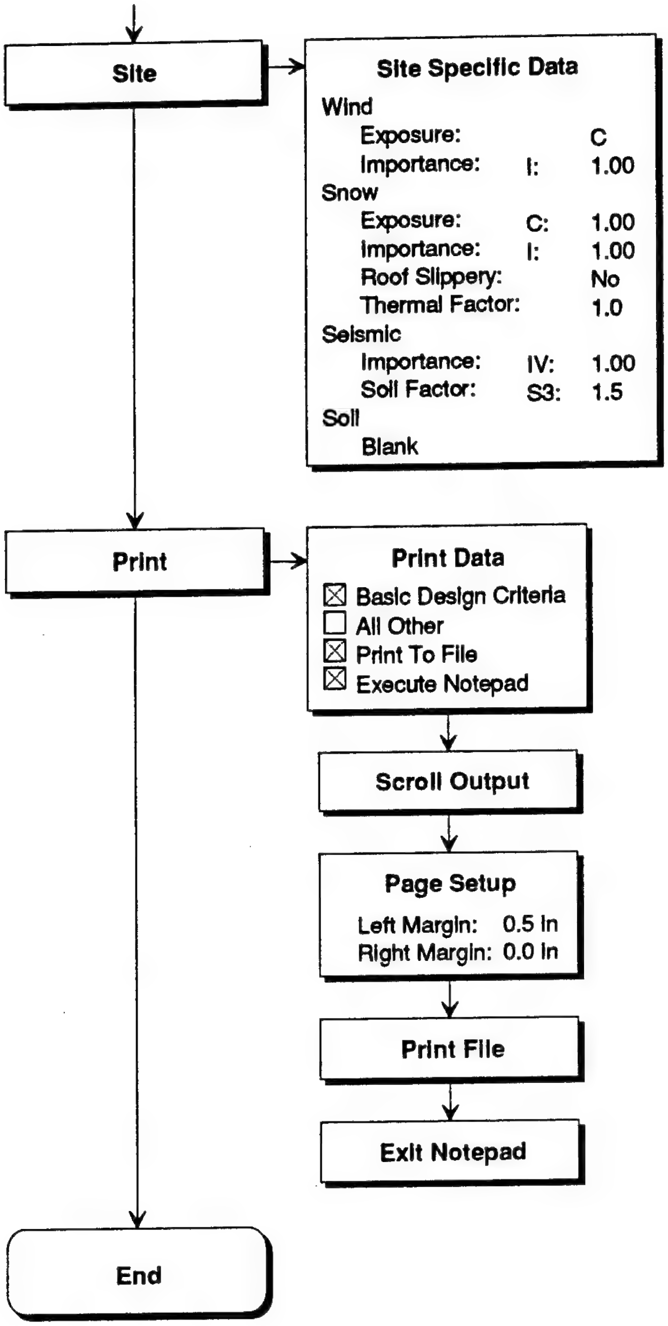
↓

Regional → Review Regional Data

Review Regional Data

Wind	
Basic Wind Speed:	70.0 mph
Coastal:	No
Maximum Wind Speed:	58.0 mph
Wind Direction:	SE
Snow	
Ground Snow Load:	25.0 psf
Maximum Snow Depth:	15.0 in
Snow Density:	17.3 pcf
Rain	
Average Annual Rainfall:	44.0 in
Maximum Rainfall:	4.0 in
Temperature	
Maximum temperature:	92 °F
Minimum Temperature:	-24 °F
Seismic Zone: 2A:	0.150
Frost Depth:	22 in

↓


Site
Site Specific Data
Wind
Exposure: C
Importance: I: 1.00
Snow
Exposure: C: 1.00
Importance: I: 1.00
Roof Slippery: No
Thermal Factor: 1.0
Seismic
Importance: IV: 1.00
Soil Factor: S3: 1.5
Soil
Blank
Print
Print Data
☒ Basic Design Criteria
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Basic Design Criteria

Project Data

Project Name	:	Office Building - Scheme C
City/Installation	:	Radford AAP
Country	:	USA
State	:	VA
County	:	Pulaski
Design Load	:	TM 5-809-1 1992
Building Code	:	BOCA
Seismic Code	:	TM 5-809-10 1992
Elevation Above Sea Level	:	3300 ft
No. of Stories	:	2
Floor Area	:	9504 sqft
Occupancy	:	Use Group B
Type of Construction	:	3A
Seismic Lateral Load Resistance		
N-S System	:	
N-S Rw	:	0
E-W System	:	
E-W Rw	:	0

Regional Data

Wind		
Basic Wind Speed From Map	:	70.0 mph
Calculated Wind Speed	:	0.0 mph
Coastal	:	No
Maximum Wind Speed	:	58.0 mph
Wind Direction	:	SE
Snow		
Ground Snow Load	:	25.0 psf
Maximum Snow Depth	:	15.0 in
Snow Density	:	17.3 pcf
Rain		
Average Annual Rainfall	:	44.0 in
Maximum Rainfall	:	4.0 in
Temperature		
Maximum Temperature	:	92.0 °F
Minimum Temperature	:	-24.0 °F
Seismic Zone : 2A	:	0.150
Frost Depth	:	22 in

Site Specific Data

Wind		
Exposure	:	C
Importance : I	:	1.00
Snow		
Exposure : C	:	1.00
Importance : I	:	1.00
Roof Slippery	:	No
Thermal Factor	:	1.0
Seismic		
Importance : IV	:	1.00
Soil Factor : S3	:	1.5

Notes

Importance Factor for Snow and Wind:

I All buildings and structures except those listed below.

II Buildings and structures where primary occupancy is one in which more than 300 people congregate in one area.

III Buildings and structures designated as essential facilities, including, but not limited to:

Hospital and other medical facilities having surgery or emergency treatment areas.

Fire or rescue and police stations.

Primary communication facilities and disaster operation centers.

Power stations and other utilities required in an emergency.

Structures having critical national defense capabilities.

IV Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities.

Wind Exposure Category:

Exposure C:

Open terrain with scattered obstructions having heights generally less than 30.0 ft.

Snow Exposure Category:

Exposure C:

Locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby.

* The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

Snow Thermal Factor:

Heated Structure.

* These conditions should be representative of those that are likely to exist during the life of the structure.

Importance Factor for Seismic:

I. Essential Facilities

Hospitals and other medical facilities having surgery and emergency treatment areas.

Fire and police stations.

Tanks or other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.

Emergency vehicle shelters and garages.

Structures and equipment in emergency preparedness centers.

Stand-by power generating equipment for essential facilities.

Structures and equipment in communication centers and other facilities required for emergency response.

II. Hazardous Facilities

Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.

III. Special Occupancy Structure

Covered structures whose primary occupancy is public assembly - capacity more than 300 persons.

Buildings for schools (through secondary) or day-care centers - capacity more than 250 students.

Buildings for colleges or adult education schools - capacity more than 500 students.

Medical facilities with 50 or more resident incapacitated patients, but not included above.

Jails and detention facilities.

All structures with occupancy more than 5000 persons.

Structures and equipment in power generating stations and other public utility facilities not included above, and required for continued operation.

IV. Standard Occupancy Structure

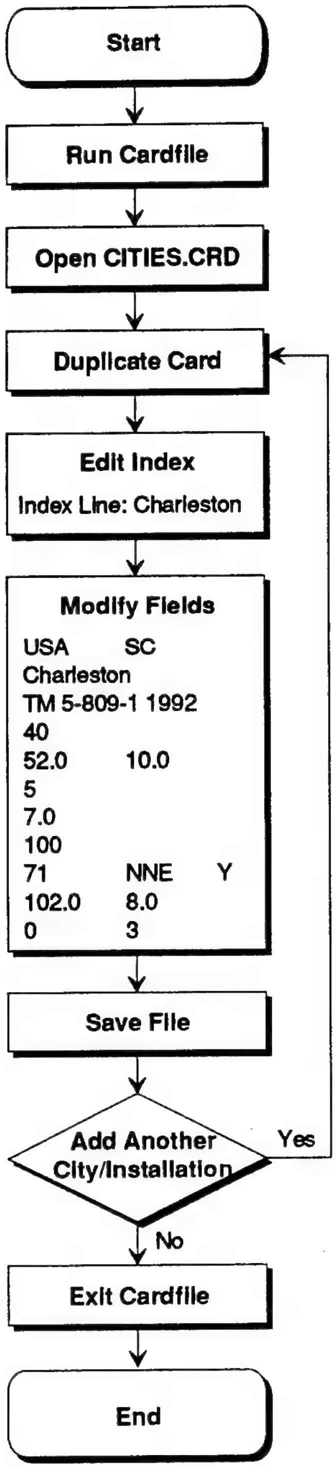
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

S3: A soil profile 70.0 ft or more in depth and containing more than 20.0 ft of soft to medium stiff clay but not more than 40.0 ft of soft clay.

The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines that soil profile S4 may be present at the site, or in the event that soil profile S4 is established by geotechnical data.

City/Installation Database



Fields

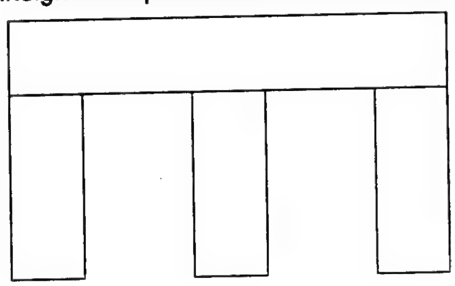
Country	State	*Metric*
County		
Design Load		
Elevation (ft)		
Ave. Rain (in)	Max. Rain (in)	
Ground Snow Load (psf)		
Max. Snow Depth (in)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (in)	Seismic Zone	

Modeling Philosophy

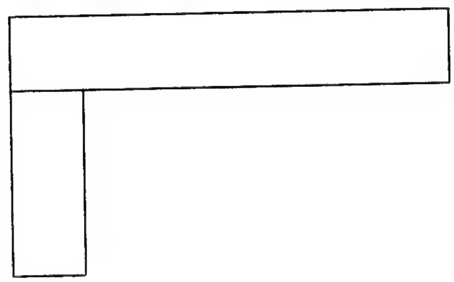
A. Simplify the geometric model

For buildings with repetitive wings, only one wing needs to be modeled.

Insignificant portions such as chimneys, dormers, and small projections, should not be modeled.



Extra wings are not necessary



Simplified model

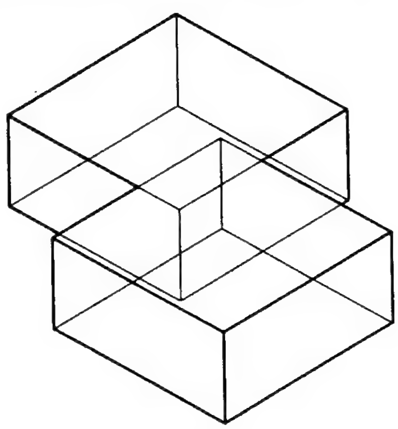
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

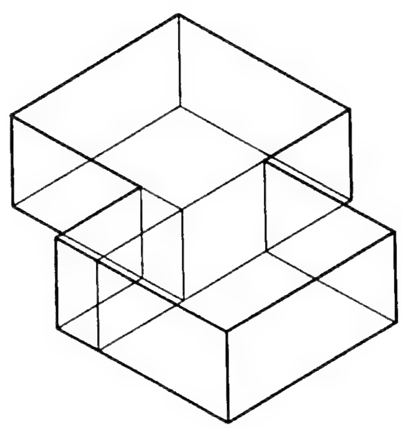
Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

When modeling parapet walls, make sure the corners do not intersect.



Incorrect

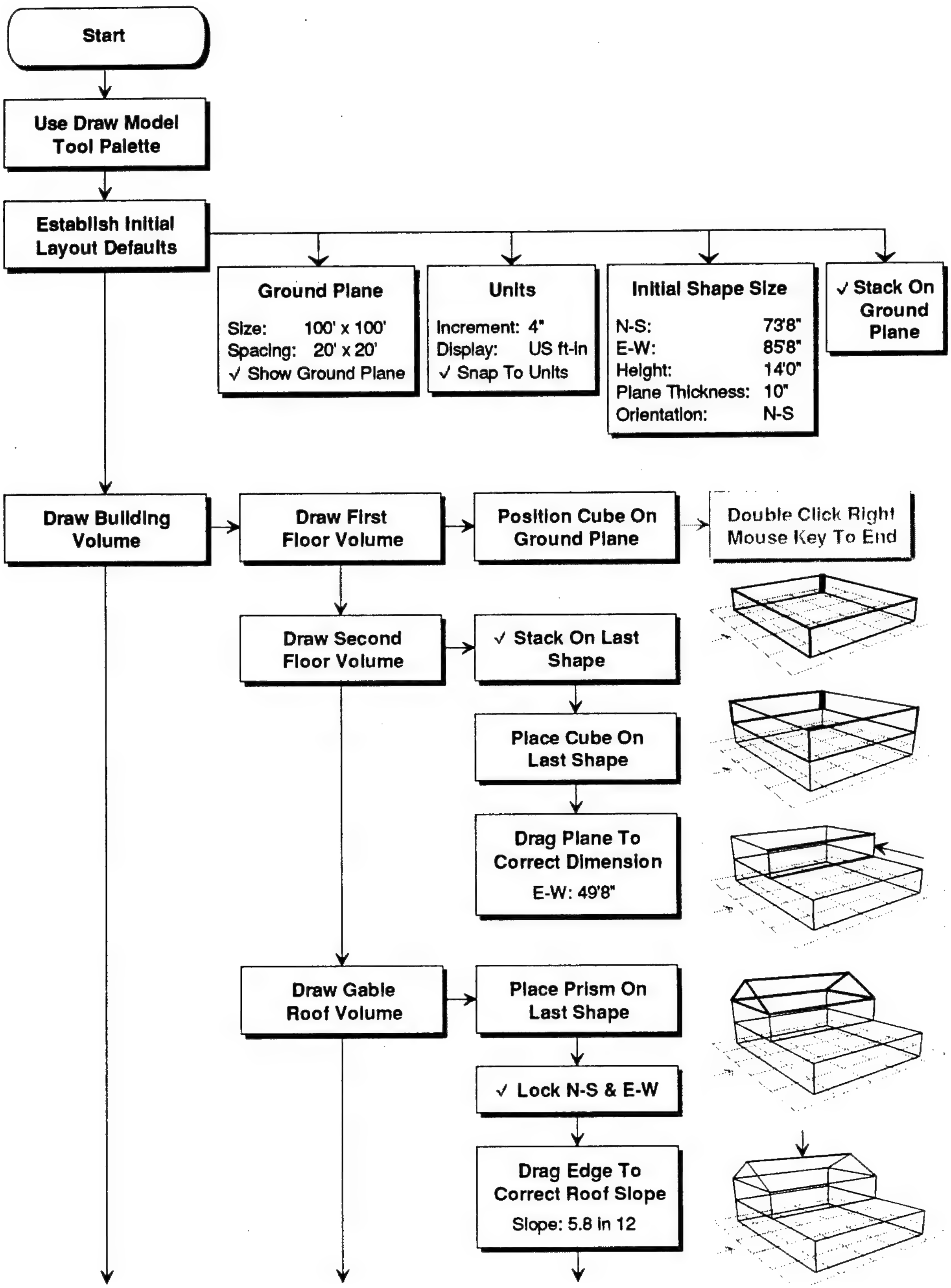


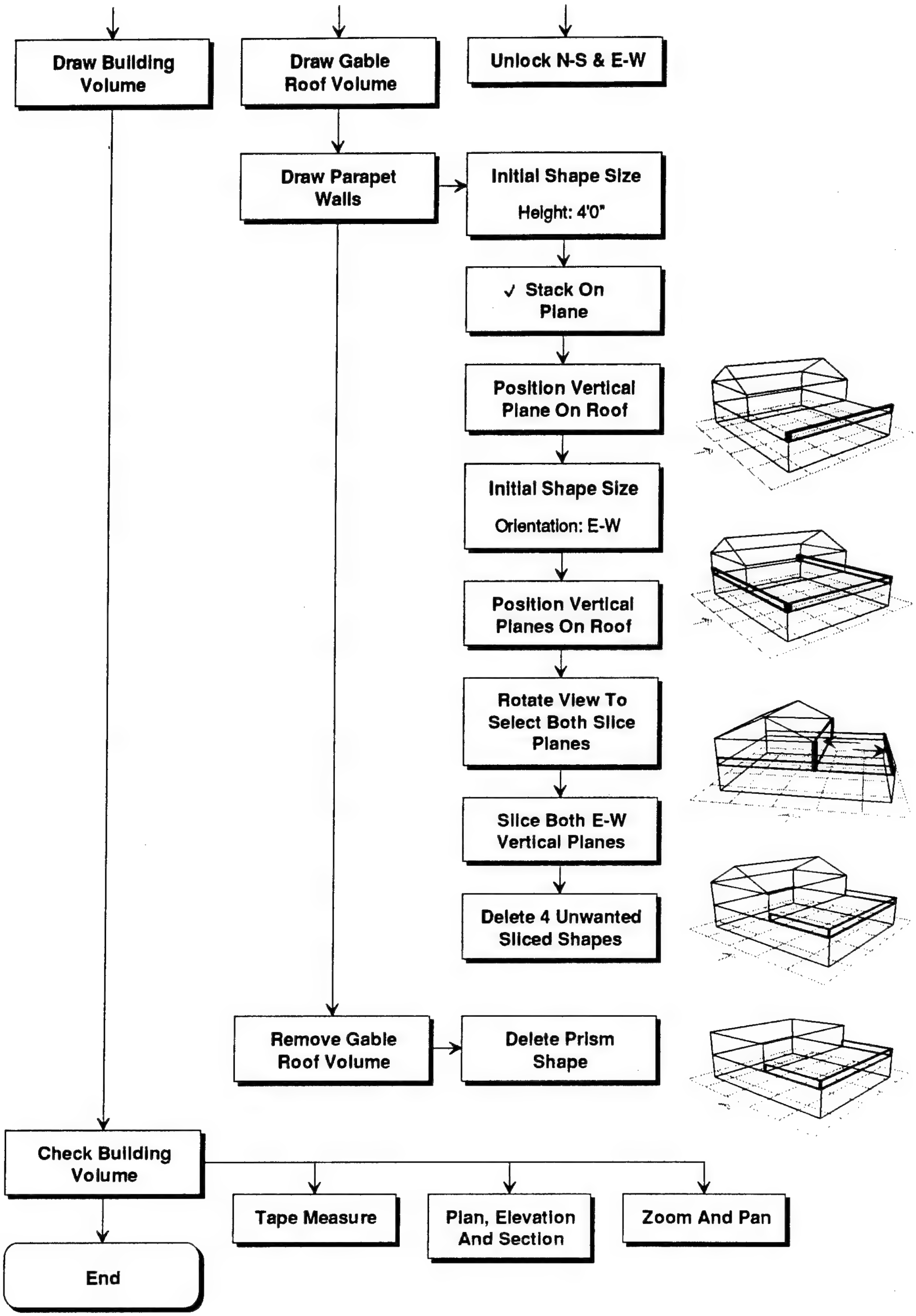
Correct

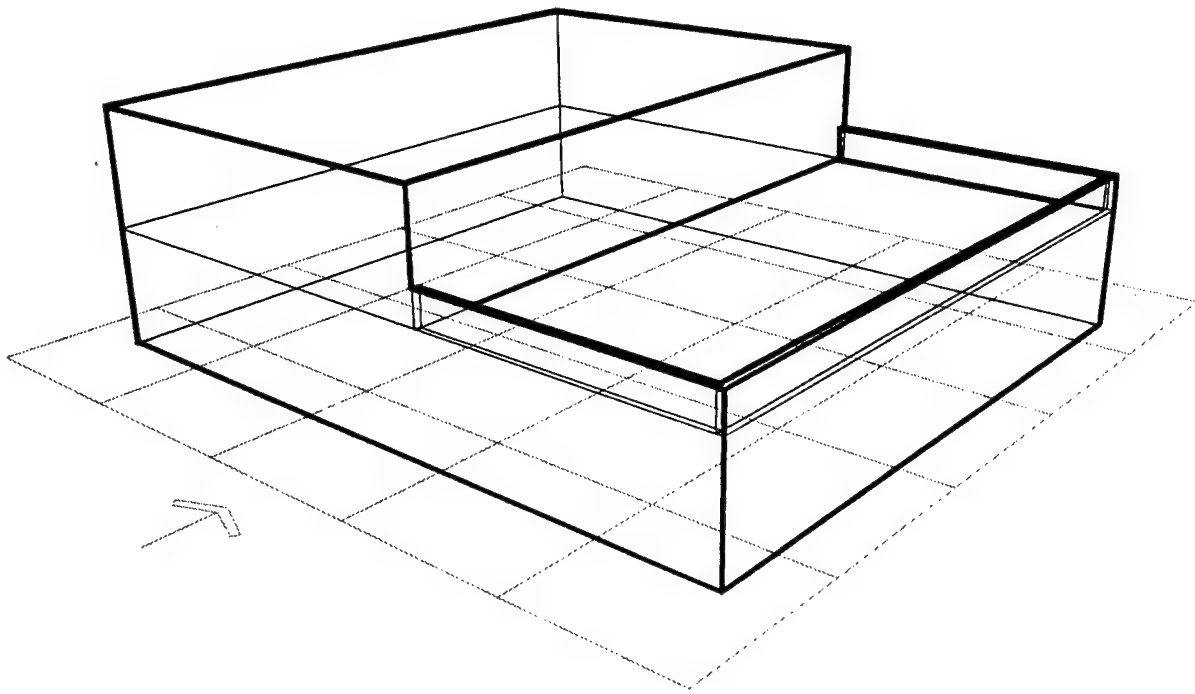
D. Verify the model

Use the Tape Measure command, zoom in on a plan, elevation and 3-D views to verify the model.

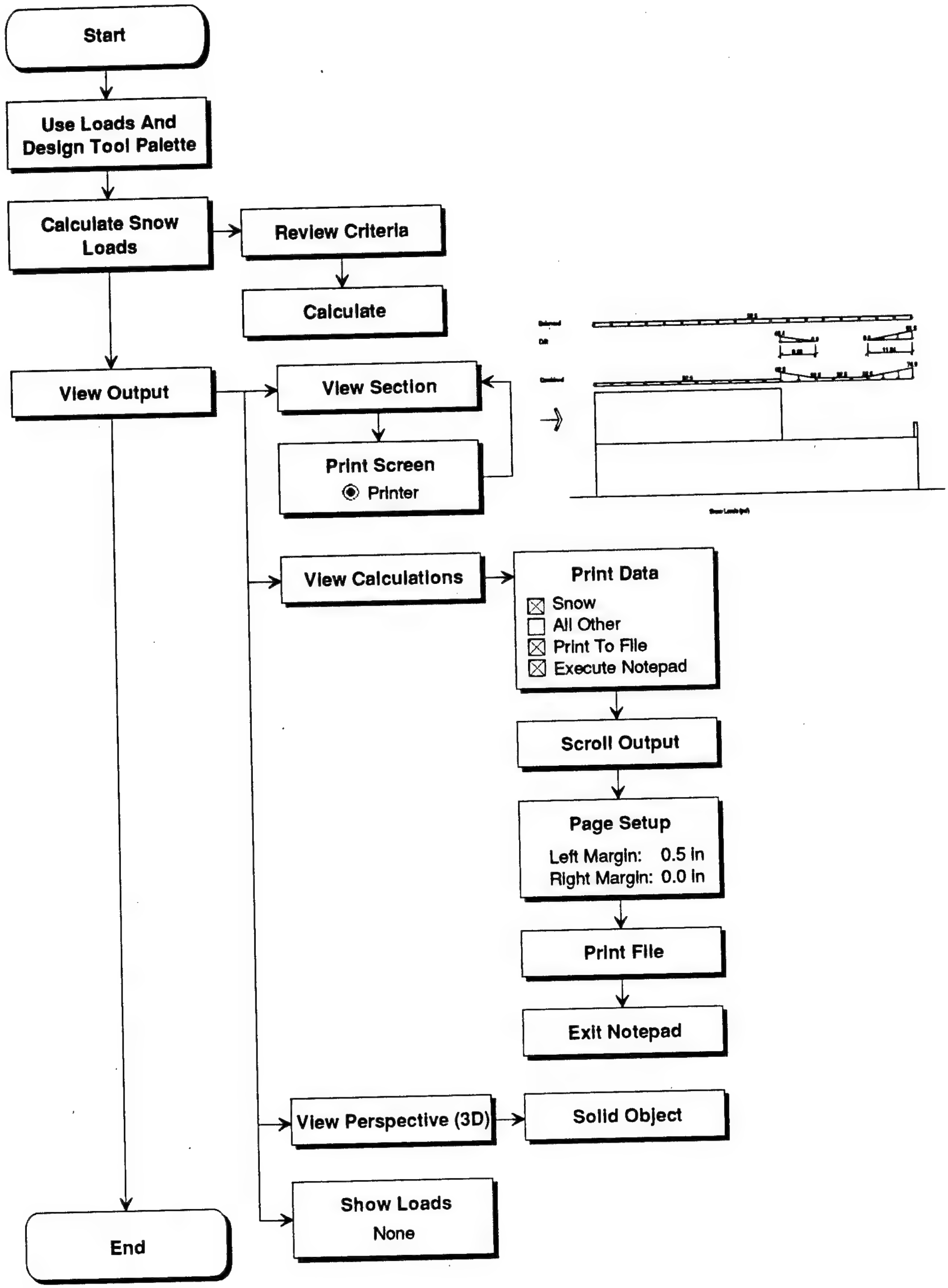
Draw Model


Start
Use Draw Model Tool Palette
Establish Initial Layout Defaults
Ground Plane
Size: 100' x 100'
Spacing: 20' x 20'
√ Show Ground Plane
Units
Increment: 4"
Display: US ft-in
√ Snap To Units
Initial Shape Size
N-S: 73'8"
E-W: 85'8"
Height: 14'0"
Plane Thickness: 10"
Orientation: N-S
√ Stack On Ground Plane
Draw Building Volume
Draw First Floor Volume
Position Cube On Ground Plane
Double Click Right Mouse Key To End
Draw Second Floor Volume
√ Stack On Last Shape
Place Cube On Last Shape
Drag Plane To Correct Dimension
E-W: 49'8"
Draw Gable Roof Volume
Place Prism On Last Shape
√ Lock N-S & E-W
Drag Edge To Correct Roof Slope
Slope: 5.8 in 12

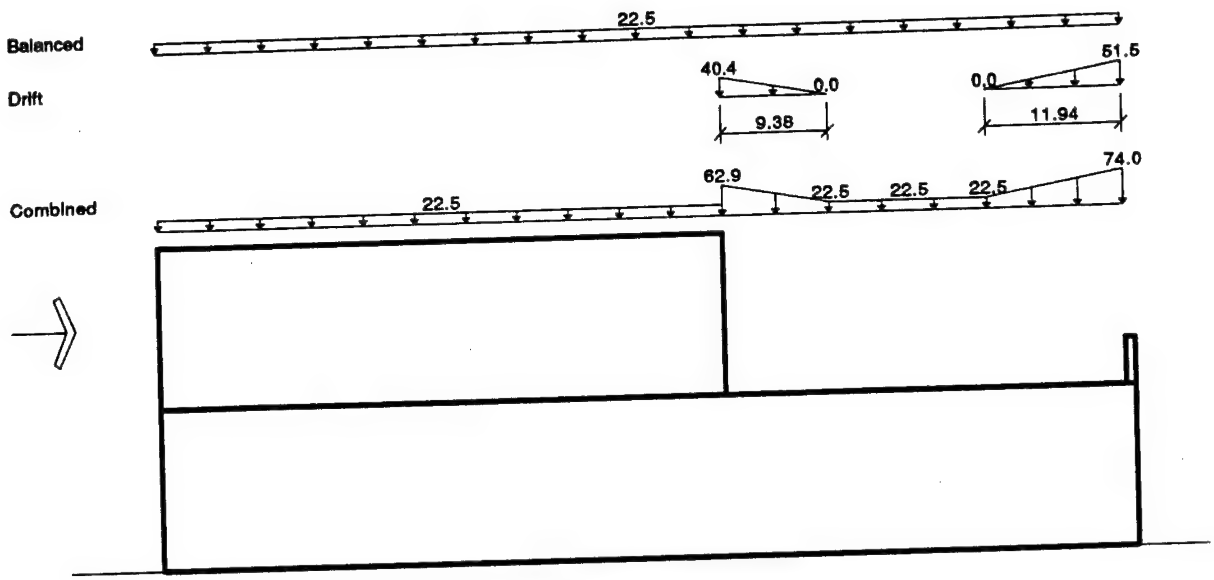

Draw Building Volume
Draw Gable Roof Volume
Unlock N-S & E-W
Draw Parapet Walls
Initial Shape Size
Height: 4'0"
✓ Stack On Plane
Position Vertical Plane On Roof
Initial Shape Size
Orientation: E-W
Position Vertical Planes On Roof
Rotate View To Select Both Slice Planes
Slice Both E-W Vertical Planes
Delete 4 Unwanted Sliced Shapes
Remove Gable Roof Volume
Delete Prism Shape
Check Building Volume
Tape Measure
Plan, Elevation And Section
Zoom And Pan
End



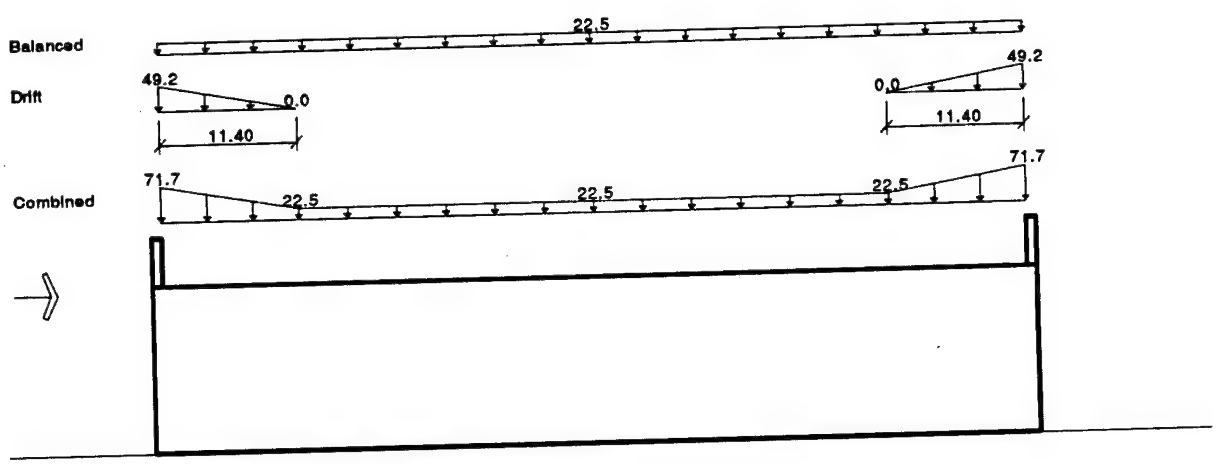
Snow Loads



Start
Use Loads And Design Tool Palette
Calculate Snow Loads
Review Criteria
Calculate
View Output
View Section
Print Screen
Printer
View Calculations
Print Data
Snow
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End



Snow Loads (psf)



Snow Loads (psf)

```
Project      : Office Building - Scheme C
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  11:39 AM

******************* Flat/Lean-To Roof Snow Load Design ********************

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*Ct*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I  = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Since theta < 0.5 in/ft, 5.0 psf rain-on-snow surcharge applies.
Pf = 22.50 psf
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20.0*I
Min Pf = 20.00 psf
+-------------------------+
|     Pf = 22.50 psf      |
+-------------------------+

Sloped Roof Snow Load (Ps)
Ps = Cs*Pf
Roof Slippery: No
Cs = 1.00
+-------------------------+
|     Ps = 22.50 psf      |
+-------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 84.83 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 3.10 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 12.38 ft
w = 4*hc = 11.94 ft
+-------------------------+
|      W = 11.94 ft       |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 3.10 ft
hd > hc, therefore hd = hc = 2.99 ft
Pd = hd*density
```

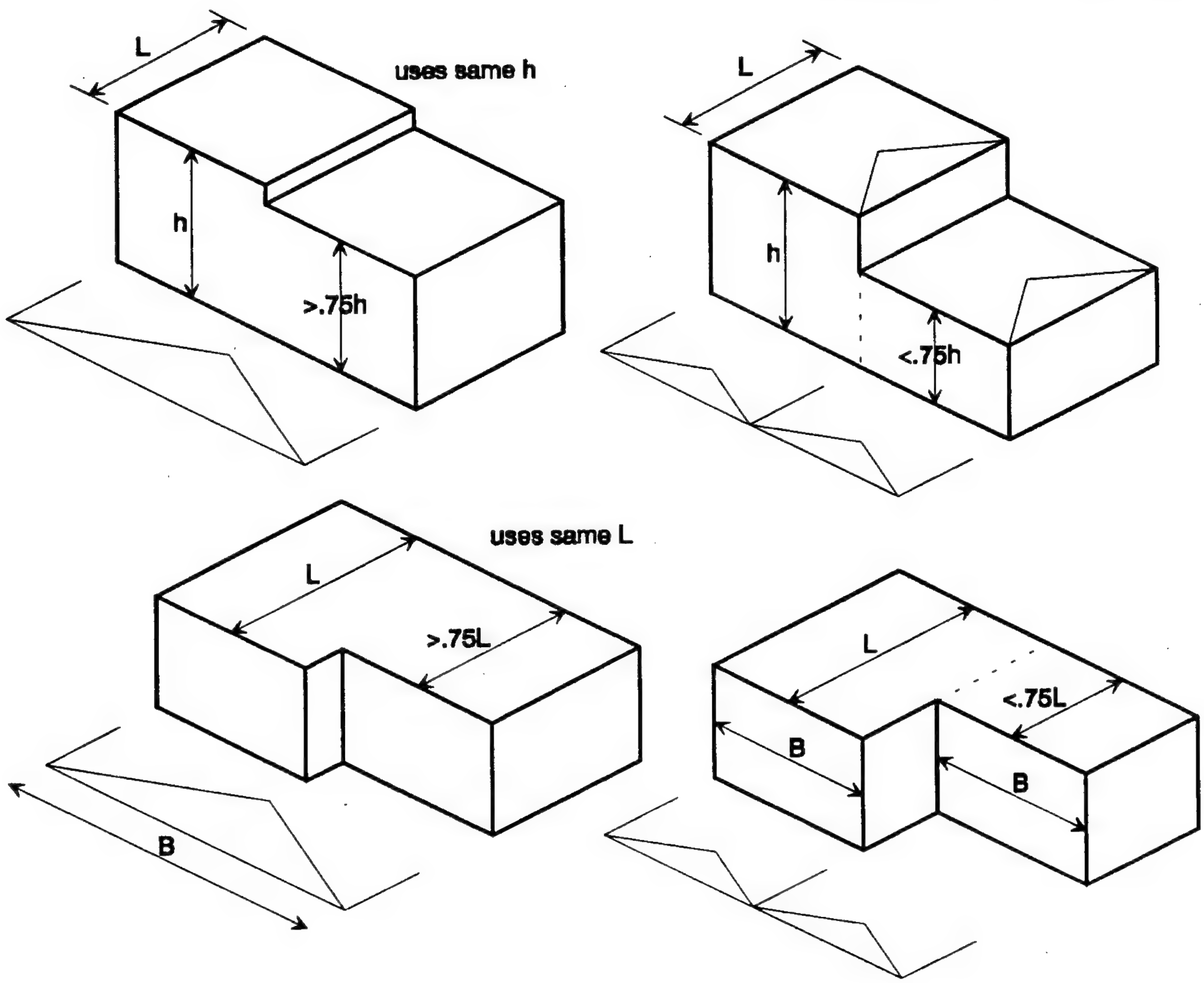
```
+-------------------------+
|     Pd = 51.50 psf      |
+-------------------------+

************************* Drift Snow Load Design **************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 72.00 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.85 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 11.40 ft
w = 4*hc = 11.94 ft
+-------------------------+
|      W = 11.40 ft       |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 2.85 ft
hd <= hc
Pd = hd*density
+-------------------------+
|     Pd = 49.18 psf      |
+-------------------------+

************************* Drift Snow Load Design **************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.99 ft
hc/hb = 12.80 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.34 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft
+-------------------------+
|      W = 9.38 ft        |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 2.34 ft
hd <= hc
```

```
Pd = hd*density
+-------------------------+
|     Pd = 40.44 psf      |
+-------------------------+
```

Wind Assumptions

Proportions For B/L & h/L

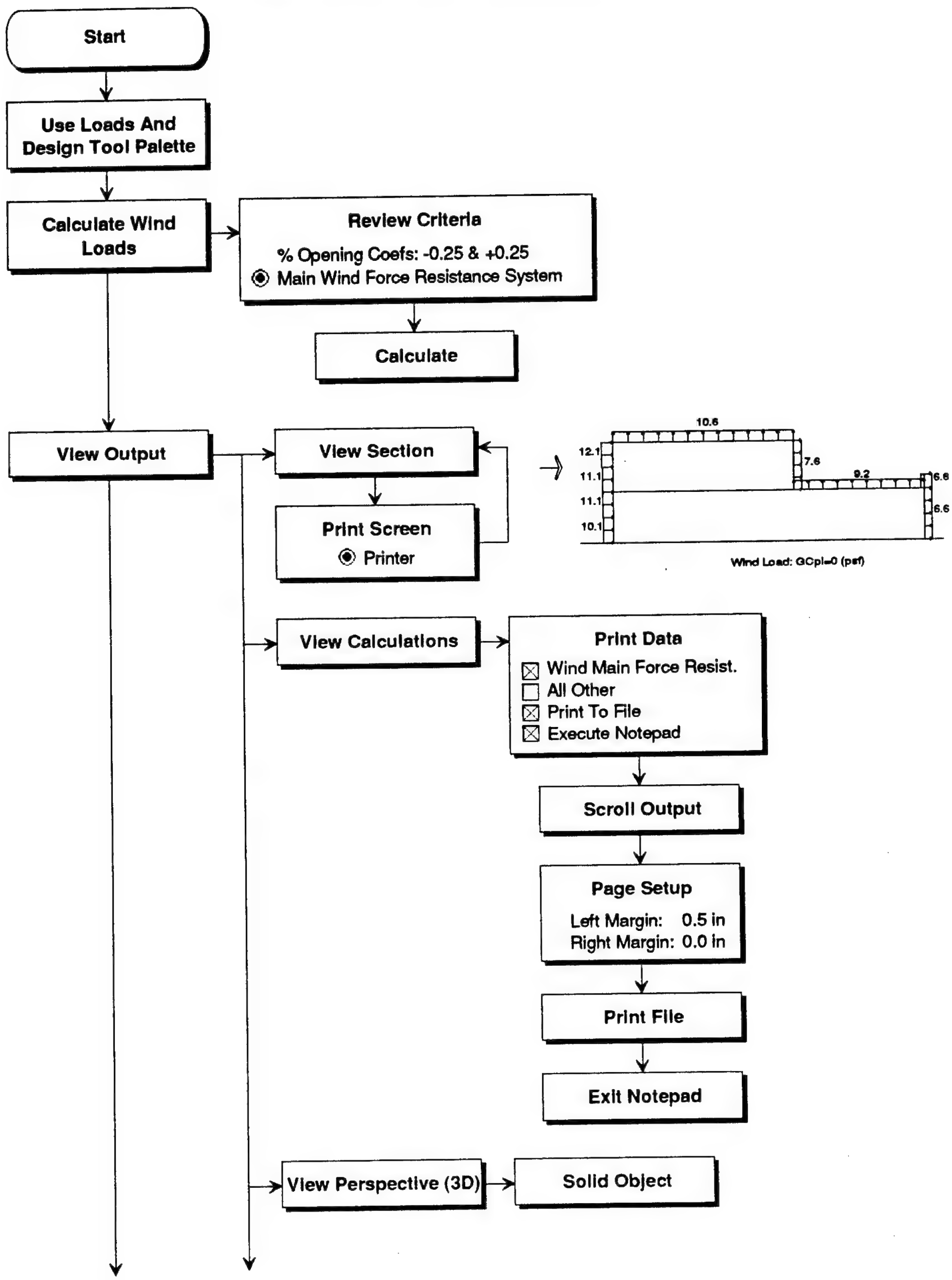
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

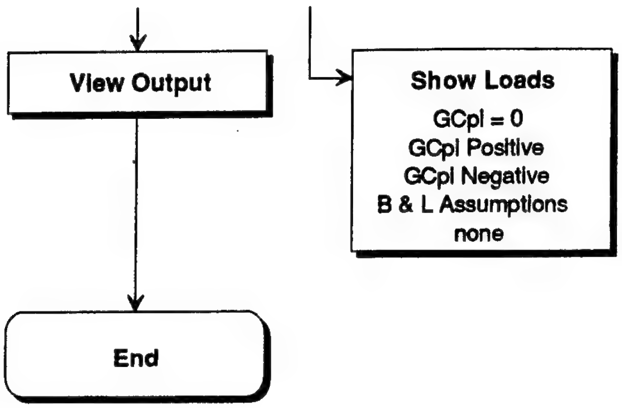


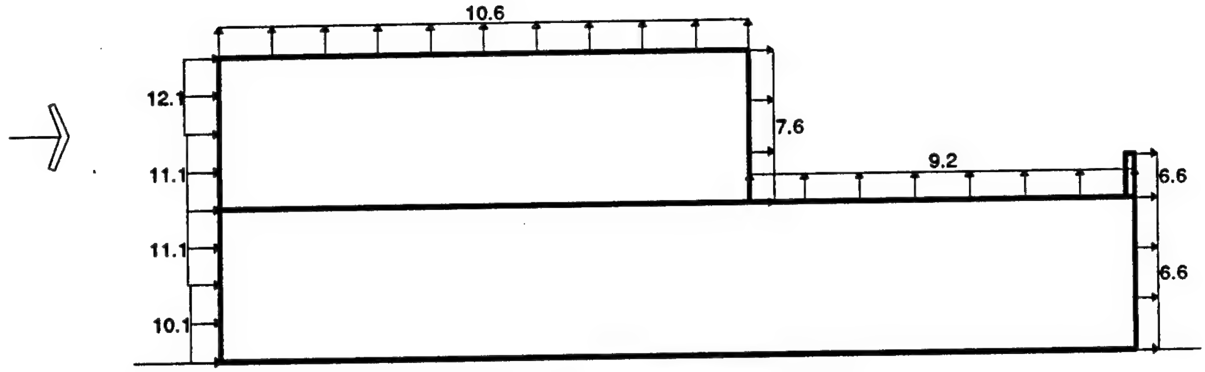
Building Height Maximum 60 Feet

Assumed for components and cladding

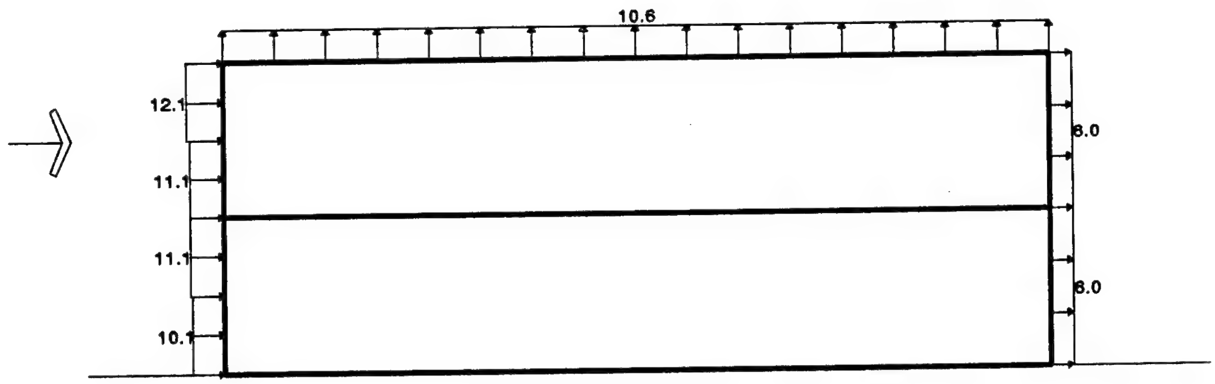
Main Wind Force Resisting Loads



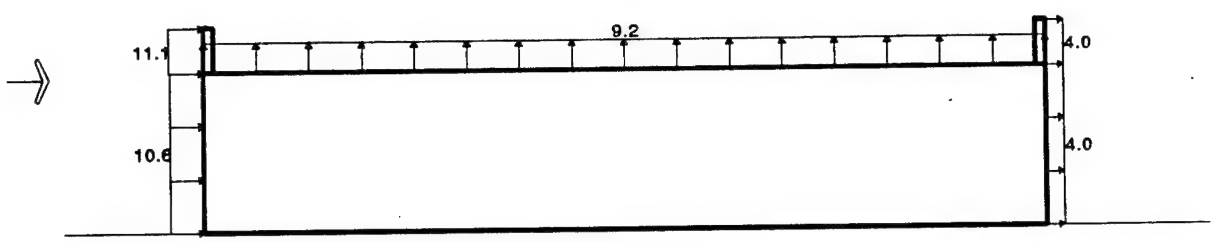

View Output
Show Loads
GCpi = 0
GCpi Positive
GCpi Negative
B & L Assumptions
none
End



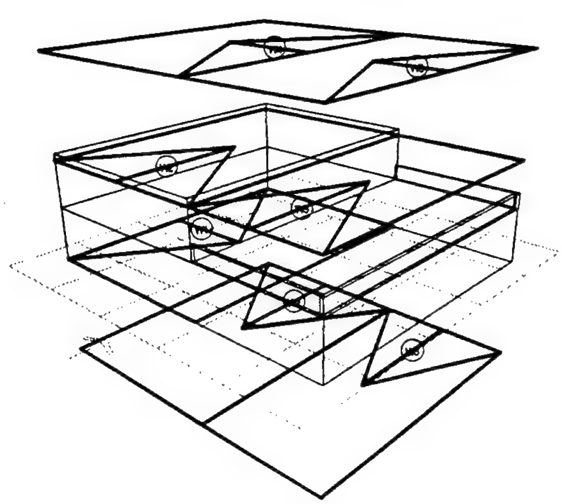
Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Project : Office Building - Scheme C
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Mon Aug 29, 1994 4:13 PM

****************************** Wind Load - 1 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi h/d = 0.56 <= 5

************************ Main Framing Pressures ************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

****************************** Wind Load - 2 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi h/d = 0.56 <= 5

************************ Main Framing Pressures ************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0	-3.0	-9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

****************************** Wind Load - 3 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	36.0	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.50	-6.6	-4.1	-9.1
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

****************************** Wind Load - 4 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 2	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 1 - 2	14.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

****************************** Wind Load - 5 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	36.0	73.7	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures ***************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.30	-4.0	-1.5	-6.5
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Notes for main framing:

Positive pressures act toward surfaces.

Pressure or suction = P = q*Gh*Cp-qh*(GCpi)

q: qz for windward wall evaluated at height z.

qh for leeward wall, side walls, and roof evaluated at mean roof height.

** For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:

(1) Values are to be used with qz or qh as specified in Table 4.

(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.

(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Wind Components & Cladding Loads

Start

Use Loads And Design Tool Palette

View Perspective (3D)

Calculate Wind Loads

Review Criteria

% Opening Coefs: -0.25 & +0.25

◉ Components & Cladding

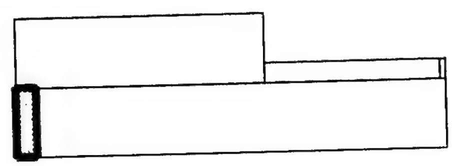
Calculate

Select Wall Plane

Tributary Area

	Horizontal	Vertical
Base Point:	0'0"	0'0"
Point 2:	4'0"	14'0"
Length:	4'0"	14'0"

F2 Key For Keyboard Input



Wind Components & Cladding

☐ Add Opposite Side Of Roof

Name: Limestone Panel

Component Tributary Width

Yes, Use Code Provision

Cancel Defining Tributary Areas

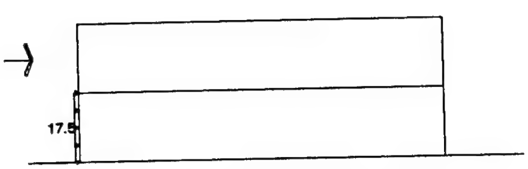
Mouse: Double Click Right Mouse Key

View Output

View Section

Print Screen

◉ Printer

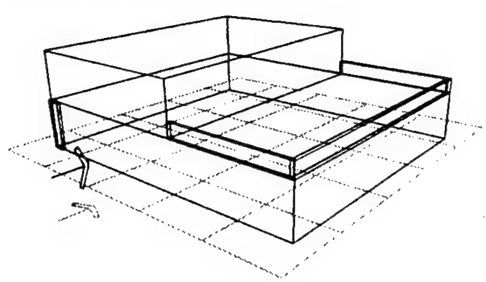


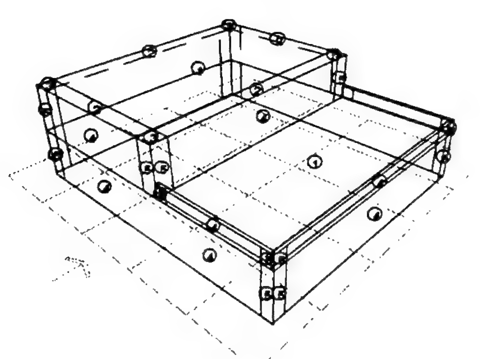
Wind Load: Components & Cladding (psf)

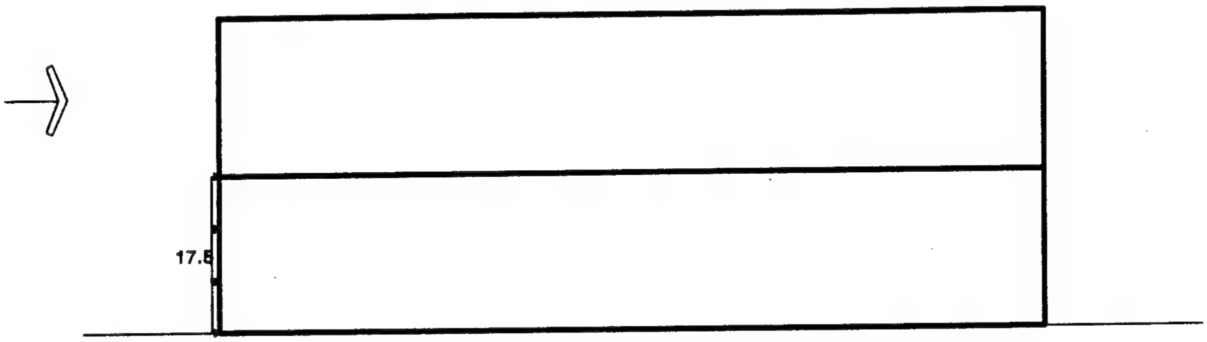
View Output

- **View Calculations** → **Print Data**
  - ☒ Wind Comp. & Clad.
  - ☐ All Other
  - ☒ Print To File
  - ☒ Execute Notepad
  - → **Scroll Output**
  - → **Page Setup**
    - Left Margin: 0.5 in
    - Right Margin: 0.0 in
  - → **Print File**
  - → **Exit Notepad**
- **View Perspective (3D)** → **Solid Object**
- **Show Loads**
  - Components & Cladding
  - Components & Cladding Zone Areas
  - none

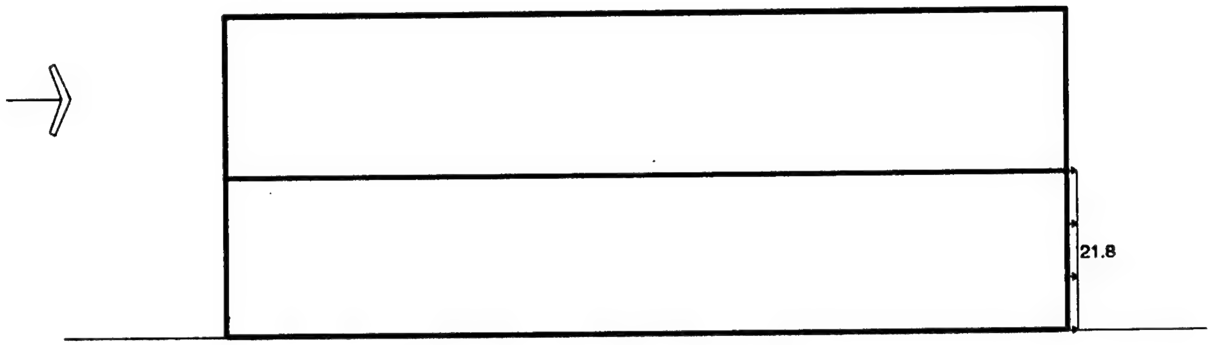
End



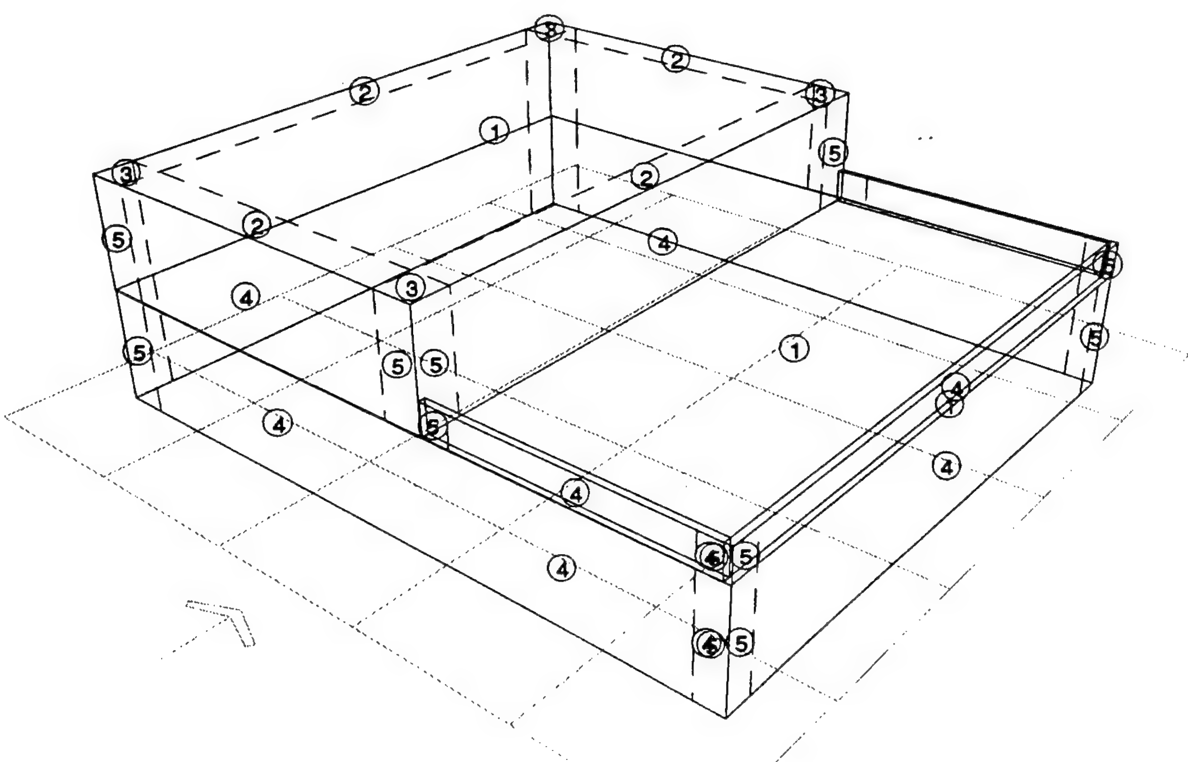




Wind Loads: Components & Cladding (psf)



Wind Loads: Components & Cladding (psf)



Project : Office Building - Scheme C
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Mon Aug 29, 1994 4:32 PM

******************************** Wind Load ********************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi h/d = 0.56 <= 5

Height (ft)	Kh	qh (psf)	GCpi	
28.0	0.96	12.0	-0.25	0.25

Height <= 60.0 ft

******************* Component/Cladding Pressures (psf) ********************

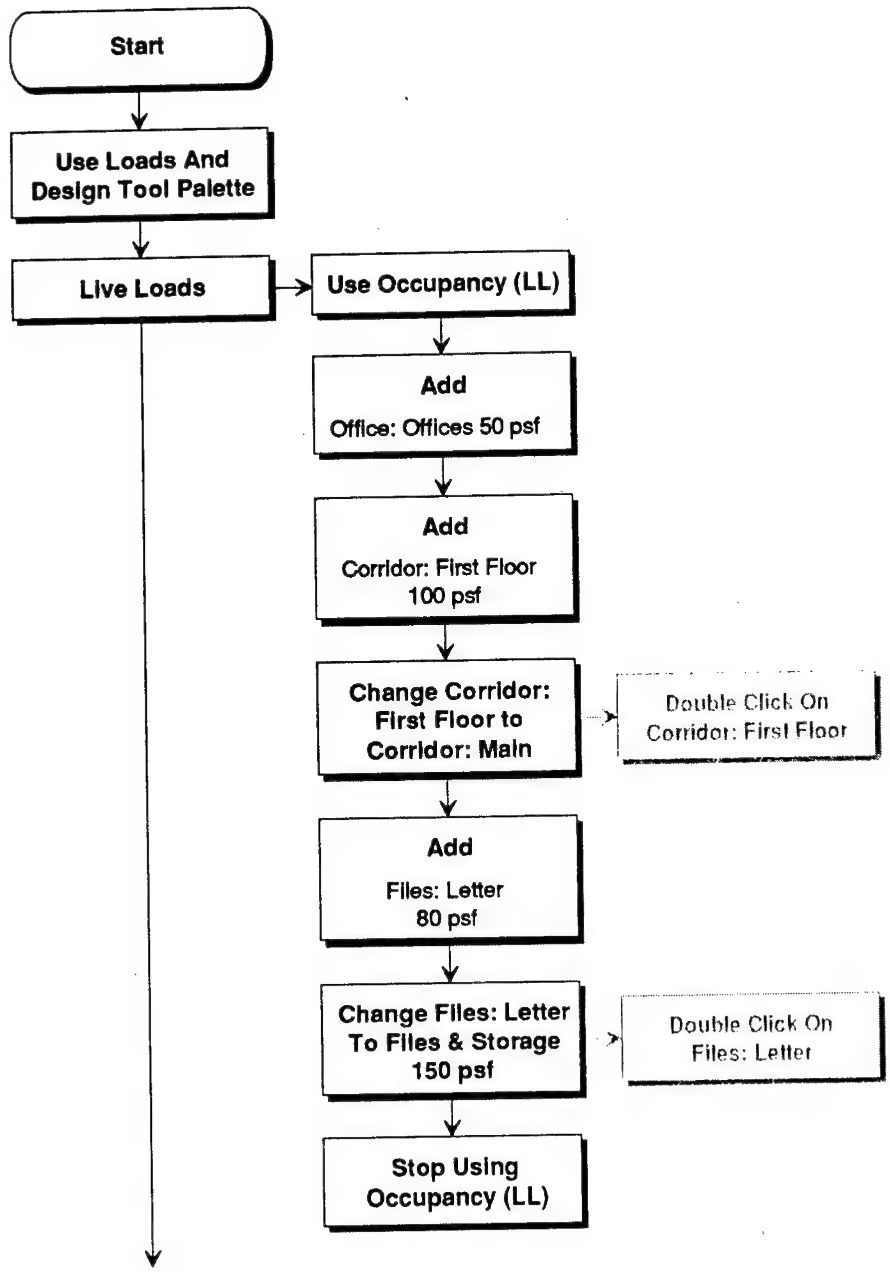
	Walls							
	Windward				Leeward			
Tributary Area (sf)	Zone 4 middles		Zone 5 corners		Zone 4 middles		Zone 5 corners	
	GCp	P	GCp	P	GCp	P	GCp	P
Internal		-3.0		-3.0		3.0		3.0
Limestone Panel 4.67 ft x 14.00 ft **								
65.3	1.21	17.5	1.21	17.5	-1.31	-18.7	-1.57	-21.8
				a = 5.0 ft				

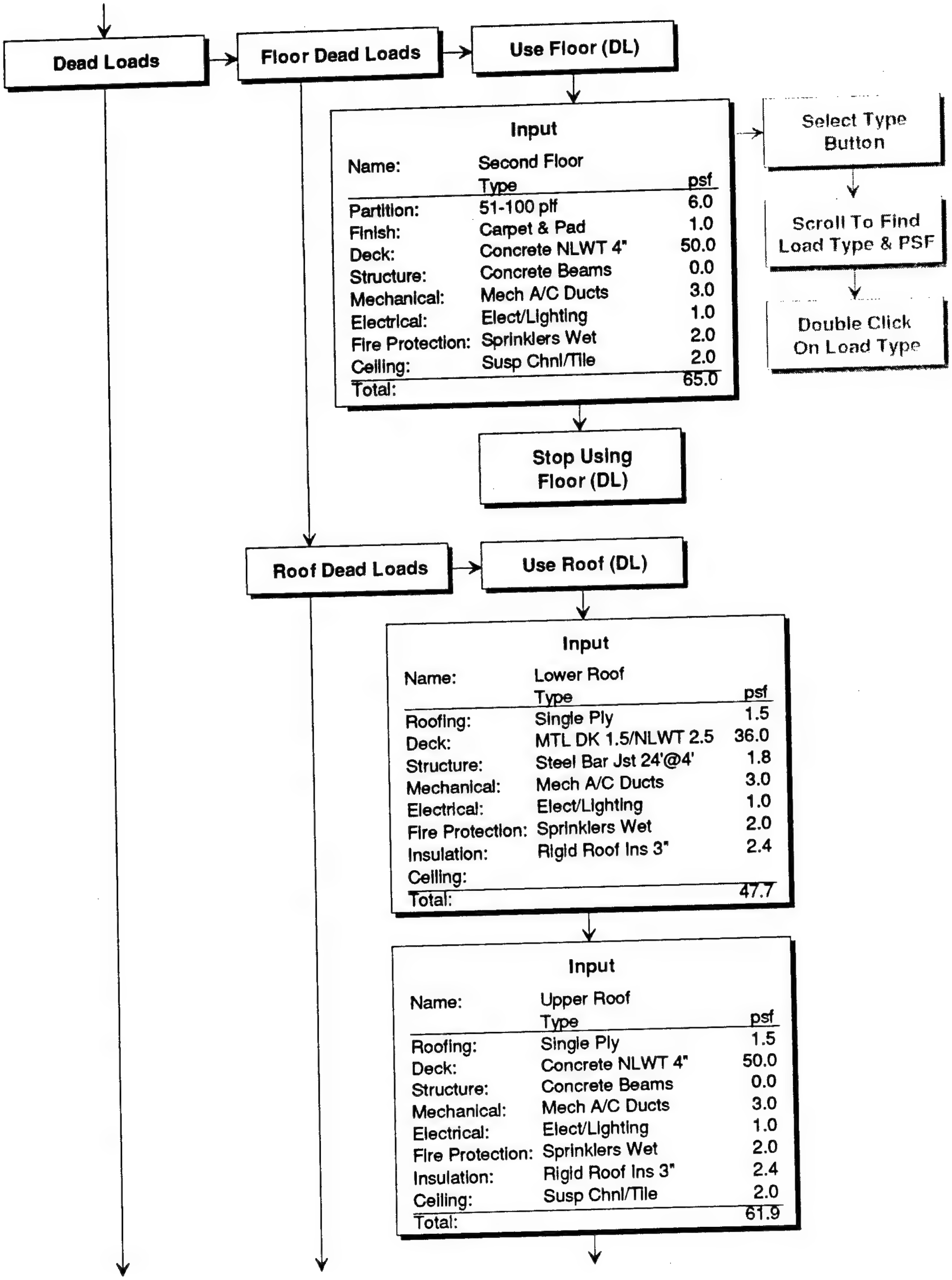
Notes for components and cladding:
P = qh(GCp)-qh(GCpi)
Internal pressures have been included in above values.
To comply with TM 5-809-1, wall external pressures have not been reduced 10% per ASCE figure 3, note 3.
** For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.
Internal Pressure Coefficients for Buildings, GCpi:

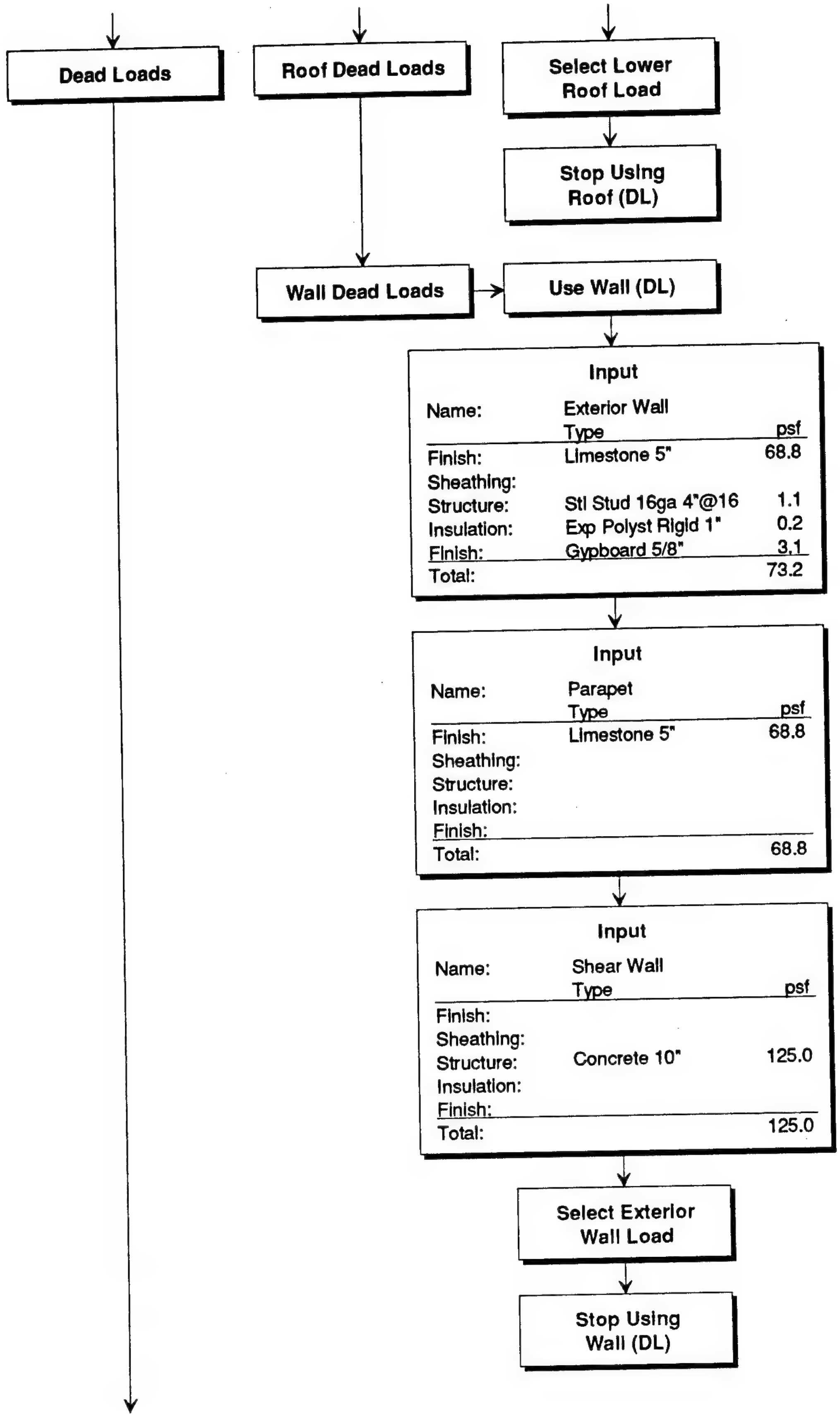
	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

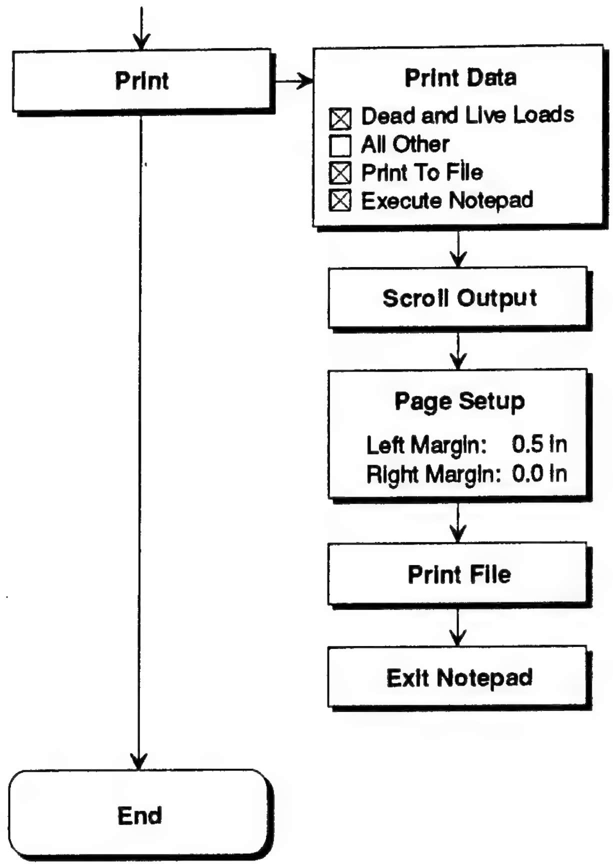
Notes:
(1) Values are to be used with qz or qh as specified in Table 4.
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.
(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Dead & Live Loads




Dead Loads
Floor Dead Loads
Use Floor (DL)
Input
Name: Second Floor
Type psf
Partition: 51-100 plf 6.0
Finish: Carpet & Pad 1.0
Deck: Concrete NLWT 4" 50.0
Structure: Concrete Beams 0.0
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Ceiling: Susp Chnl/Tile 2.0
Total: 65.0
Select Type Button
Scroll To Find Load Type & PSF
Double Click On Load Type
Stop Using Floor (DL)
Roof Dead Loads
Use Roof (DL)
Input
Name: Lower Roof
Type psf
Roofing: Single Ply 1.5
Deck: MTL DK 1.5/NLWT 2.5 36.0
Structure: Steel Bar Jst 24'@4' 1.8
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling:
Total: 47.7
Input
Name: Upper Roof
Type psf
Roofing: Single Ply 1.5
Deck: Concrete NLWT 4" 50.0
Structure: Concrete Beams 0.0
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling: Susp Chnl/Tile 2.0
Total: 61.9


Dead Loads
Roof Dead Loads
Select Lower Roof Load
Stop Using Roof (DL)
Wall Dead Loads
Use Wall (DL)
Input
Name: Exterior Wall
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure: Stl Stud 16ga 4"@16 1.1
Insulation: Exp Polyst Rigid 1" 0.2
Finish: Gypboard 5/8" 3.1
Total: 73.2
Input
Name: Parapet
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8
Input
Name: Shear Wall
Type psf
Finish:
Sheathing:
Structure: Concrete 10" 125.0
Insulation:
Finish:
Total: 125.0
Select Exterior Wall Load
Stop Using Wall (DL)


Print
Print Data
☒ Dead and Live Loads
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Loads

Floor Dead Loads

Name : Second Floor

	Type	psf
Partition	: 51-100 plf	6.0
Finish	: Carpet & Pad	1.0
Deck	: Concrete NLWT 4"	50.0
Structure	: Concrete Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Ceiling	: Susp Chnl/Tile	2.0
Total	:	65.0

Roof Dead Loads

Name : Lower Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: MTL DK 1.5/NLWT 2.5	36.0
Structure	: Steel Bar Jst 24'@4'	1.8
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	:	0.0
Total	:	47.7

Name : Upper Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: Concrete NLWT 4"	50.0
Structure	: Concrete Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	: Susp Chnl/Tile	2.0
Total	:	61.9

Wall Dead Loads

Name : Exterior Wall

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	: Stl Stud 16ga 4"@16	1.1
Insulation	: Exp Polysty Rigid 1"	0.2
Finish	: Gypboard 5/8"	3.1
Total	:	73.2

Name : Parapet

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	:	0.0
Insulation	:	0.0
Finish	:	0.0
Total	:	68.8

Name : Shear Wall

	Type	psf
Finish	:	0.0
Sheathing	:	0.0
Structure	: Concrete 10"	125.0
Insulation	:	0.0
Finish	:	0.0
Total	:	125.0

Occupancy Live Loads

Name	psf
Office: Offices	50
Corridor: Main	100
Files & Storage	150 a

a. These design loads are extremely variable. The design load will be increased when data is available.

Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400.0 sqft or more may be reduced with: L = Lo*[0.25+(15/sqrt(Ai))]

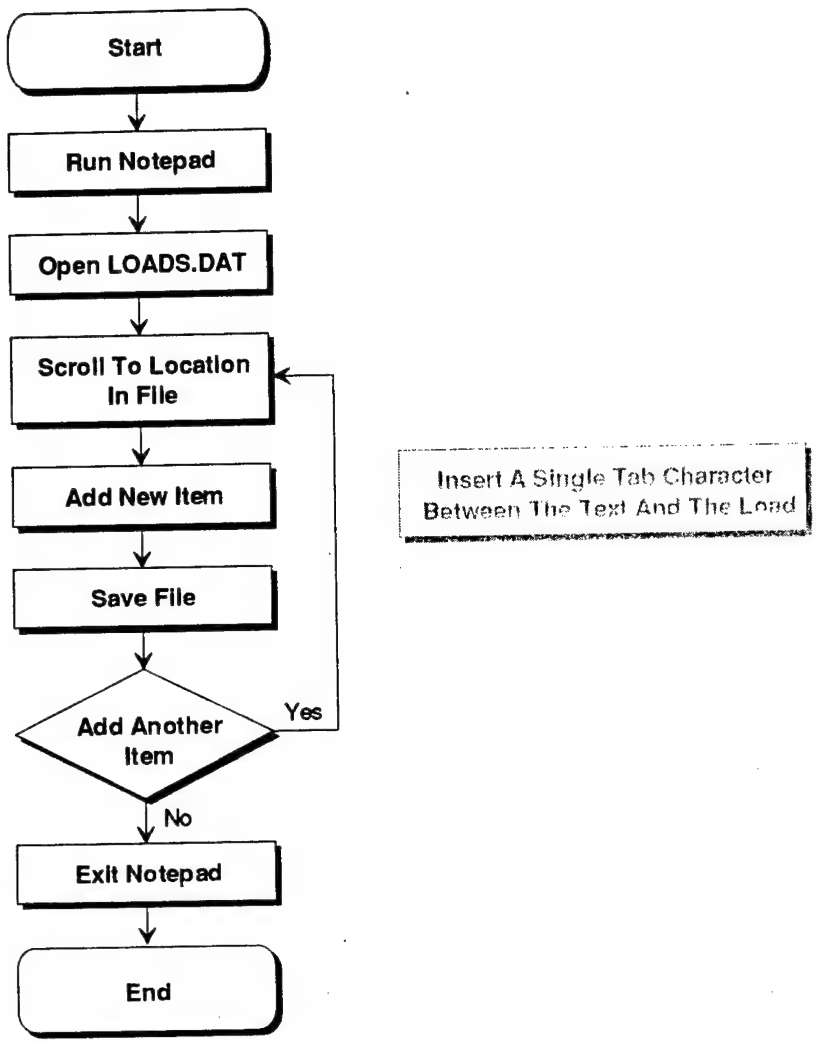
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.

Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- -public assembly
- -garages [except where 2 or more floors are supported]
- -one-way slab floor

For live loads greater than 100 psf and for garages used for passenger cars only, no reduction is permitted for members supporting one floor; however, where two or more floors are supported, a 20% reduction is permitted.

Loads Database



Draw Grid & Openings

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/ Lower Roof Horizontal Structural Plane

Structural Plane Information

Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid

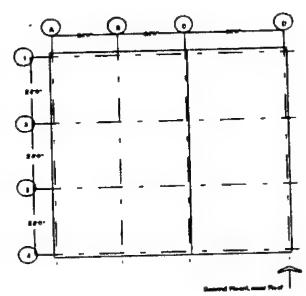
N-S Spacing: 24'0"
E-W Spacing: 24'0"
Perimeter Offset: 10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines



Draw Openings

Add Opening

	Horizontal	Vertical
Base Point:	10"	24'10"
Point 2:	8'10"	48'10"
Length:	8'0"	24'0"

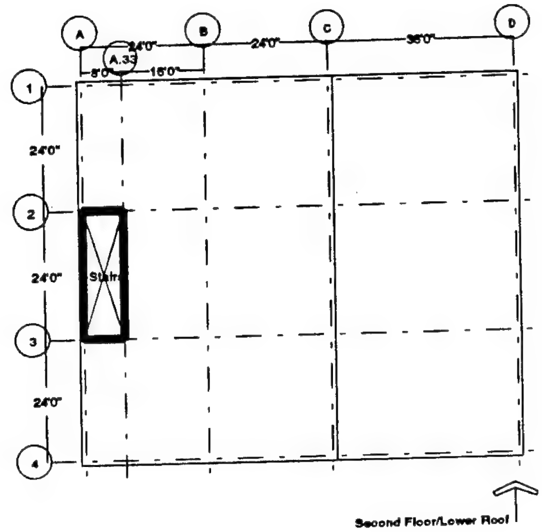
F2 Key For Keyboard Input

Opening

Name: Stairs

☐ Continuous

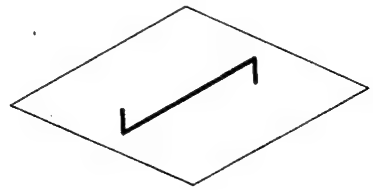
End



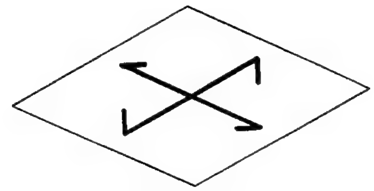
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



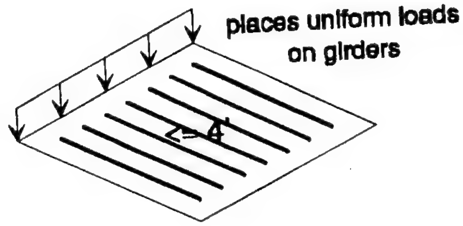
1 way



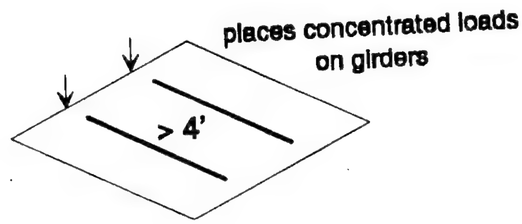
2 way
(not activated)

Linear
(horizontal)

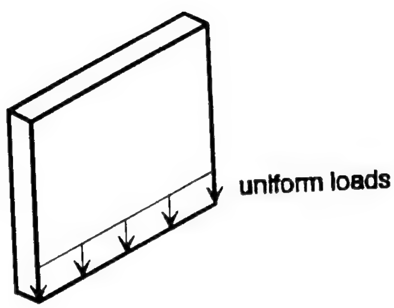
Narrowly Spaced
(joists)



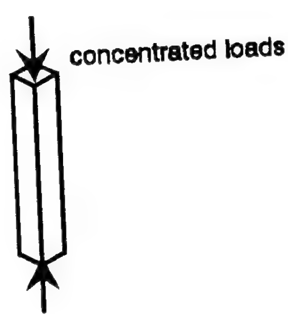
Widely Spaced
(beams)



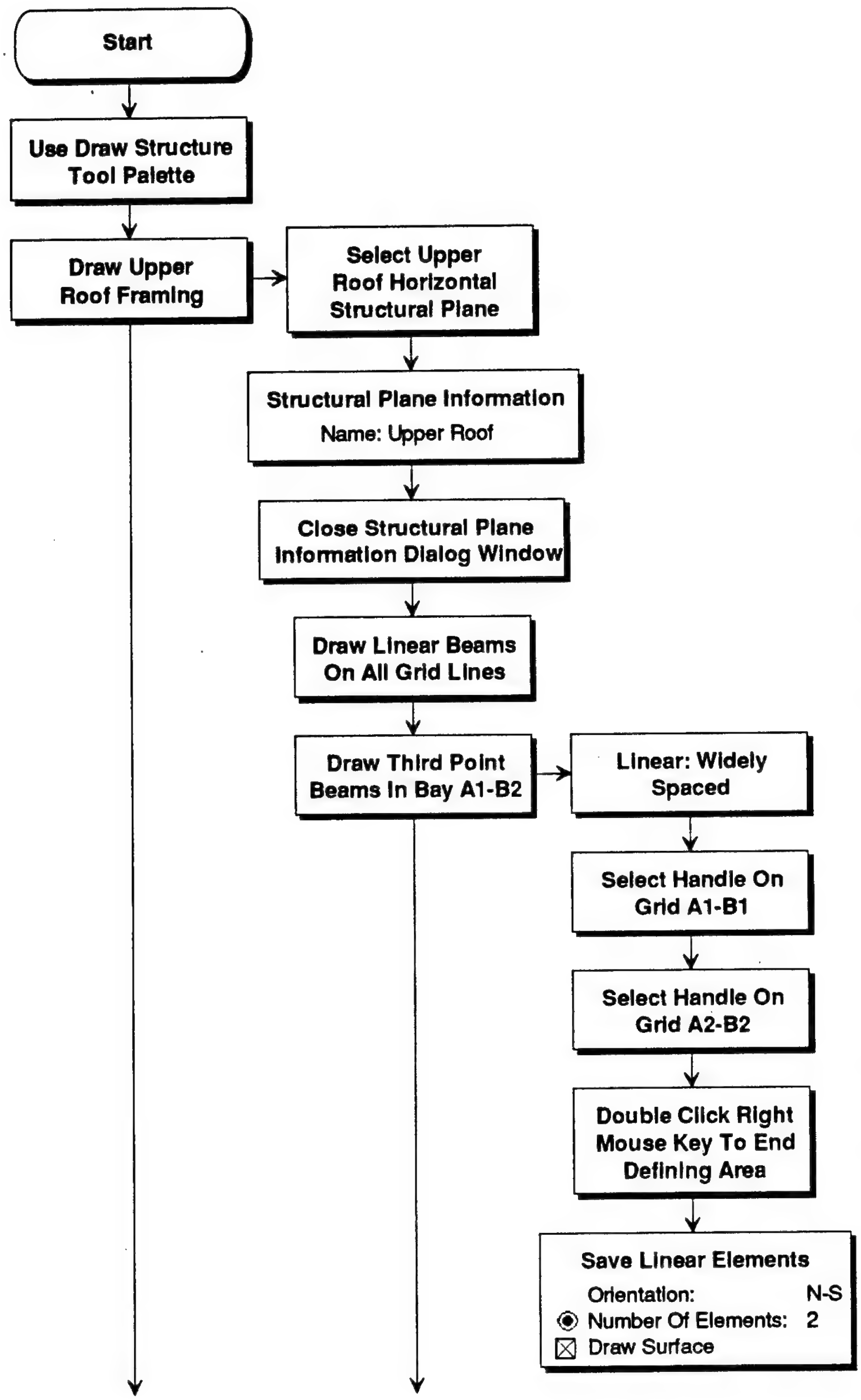
Surface
(vertical)
(planar)

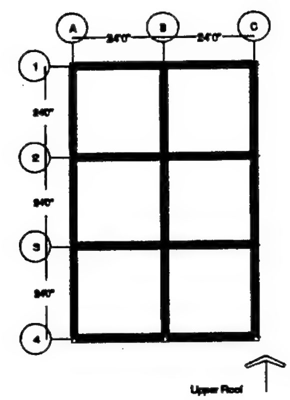


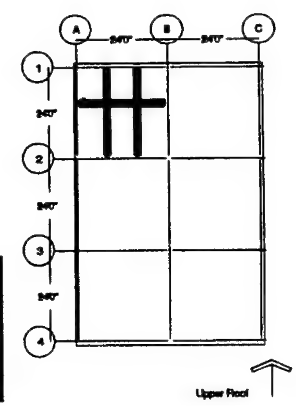
Linear
(vertical)



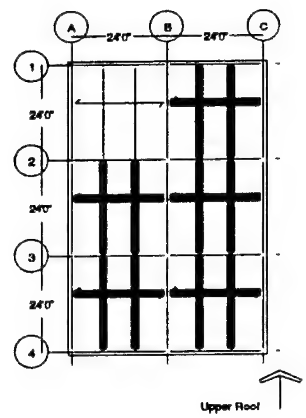
Draw Structure







- Draw Upper Roof framing
- Copy Beams & One-Way Surface To Other Bays
  - Copy Structure
  - Select Third Point Beams
  - Select One-Way Surface
  - Double Click Right Mouse Key To End Selecting Structure
  - Select Grid Location A1 As The Base Point
  - Paste Structure
  - Select Grid Locations B1, A2, B2, A3, B3
  - Double Click Right Mouse Key To End



- Delete Beams
  - Delete Structure
  - Select Beams B1-C1, C1-C2, A2-A3, B4-C4
  - Double Click Right Mouse Key To End

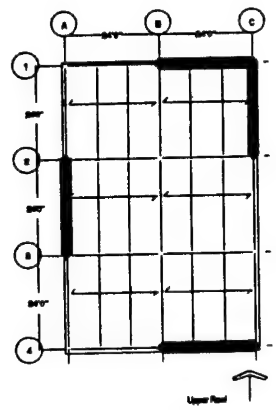
Draw Upper Roof framing

Draw Walls → **Wall 2 Grid Points**

Select B1 & C1

Save Wall Elements
- Orientation: E-W
- Start Height: 14'
- End Height: 14'
- Thickness: 10"
- ☒ All Floors
- ☒ Assign Dead Load
- Shear Wall

Repeat For C1-C2, A2-A3, B4-C4

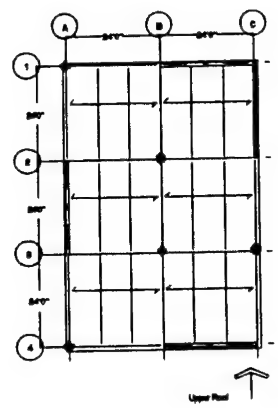


Draw Columns → **Column One Grid Intersection**

Select A1, B2, B3, C3, A4

Double Click Right Mouse Key To End

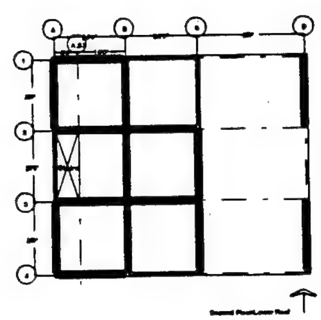
Save Column Elements
- Orientation: N-S
- ☒ All Floors



Draw Second Floor/ Lower Roof Framing → **Select Second Floor/ Lower Roof Horizontal Structural Plane**

Draw Linear Beams On All Grid Lines

Delete Beams At Grids C2-D2,C3-D3, And Over Walls



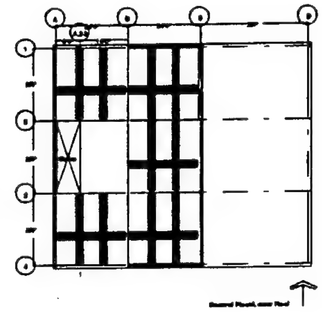
Draw Second Floor/ Lower Roof Framing

Draw Third Point Beams And One-Way Surface In Bays A1-B2, B1-C2, B2-C3, A3-B4, B3-C4

Paste Structure

Select Grid Locations A1, B1, B2, A3, B3

Double Click Right Mouse Key To End



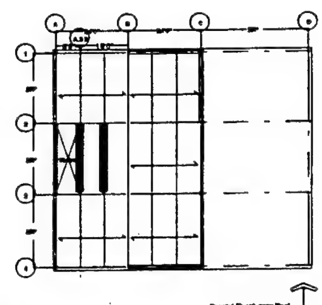
Draw Third Point Beams In Bay A2-B3

Linear: Widely Spaced

Select Handle On Grid B2-B3

Select Handle On Grid A2-A3

Double Click Right Mouse Key To End Defining Area



Save Linear Elements

Orientation: N-S

◉ Number Of Elements: 2

☐ Draw Surface

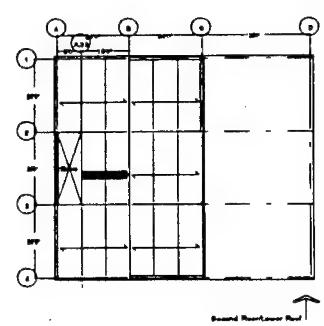
Draw Surface In Bay A.33,2-B3

Surface: One-Way

Select Handle On Grid A.33,2-A.33,3

Select Handle On Grid Line B2-B3

Double Click Right Mouse Key To End Defining Area



Draw Second Floor/ Lower Roof Framing

Draw Surface In Bay A.33,2-B3

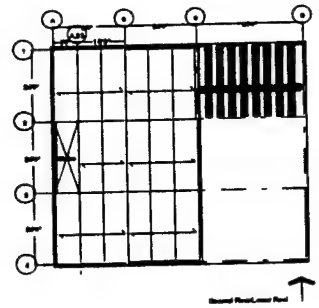
Save Surface Element
Orientation: E-W

Draw Joists In Bay C1-D2

Linear: Narrowly Spaced

Select Handle On Grid C1-D1

Select Handle On Grid C2-D2



Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: N-S
◉ Spacing: 48"
☒ Draw Surface

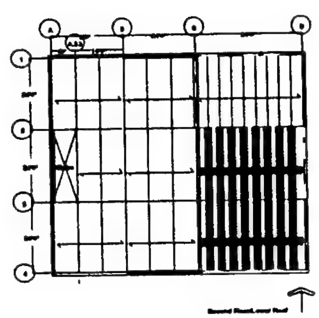
Copy Joists & One-Way Surface To Other Bays

Copy Structure

Select Joists

Select One-Way Surface

Double Click Right Mouse Key To End Selecting Structure



Paste Structure

Select Grid Locations C2, C3

Draw Second Floor/ Lower Roof Framing

Copy Joists & One-Way Surface To Other Bays

Double Click Right Mouse Key To End

Draw Trusses

Linear Truss-Custom

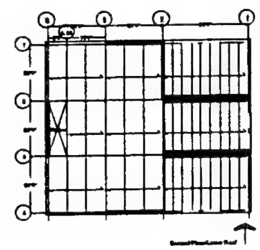
Select Grid Location C2-D2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: E-W

Truss-Custom
☐ Include Opposite Side Of Roof
Depth Of Support: 3'
Scissors Height: 0'

Repeat For Grid Location C3-D3



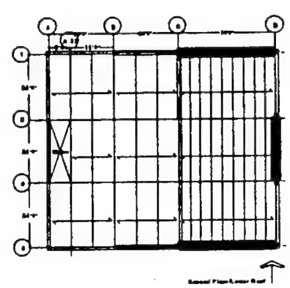
Draw Walls

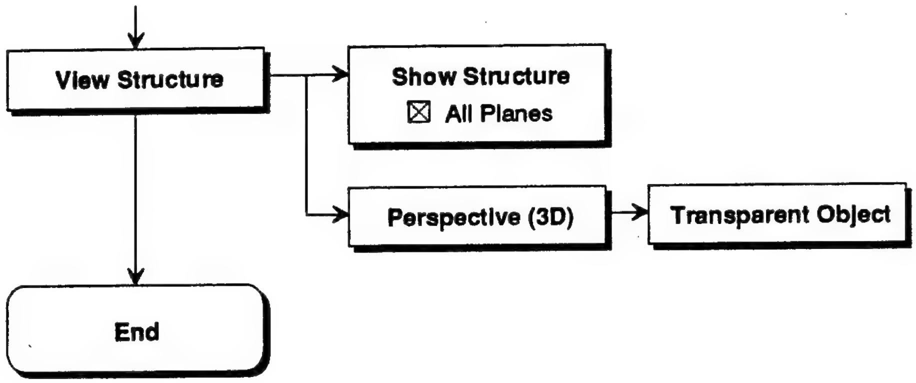
Wall 2 Grid Points

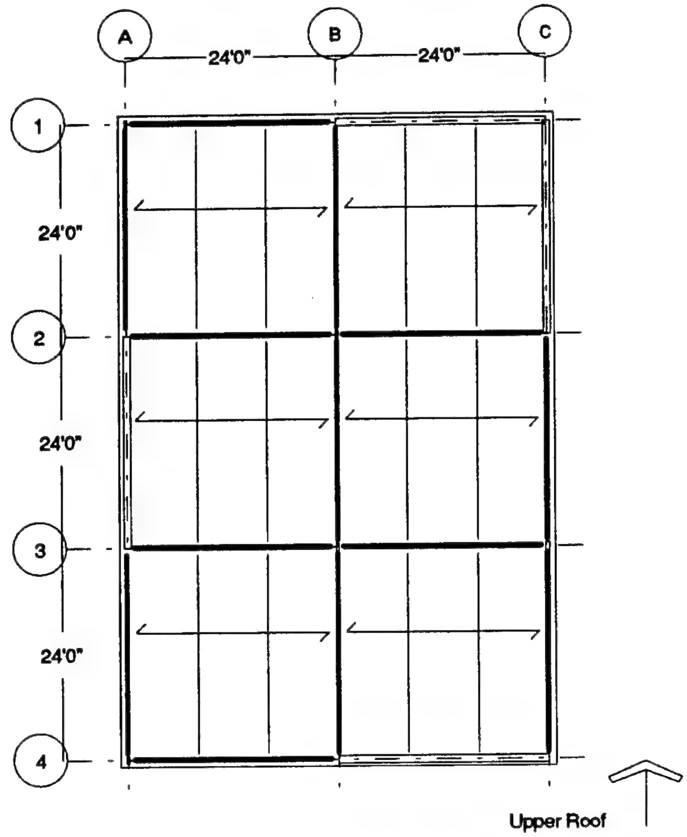
Select C1 & D1

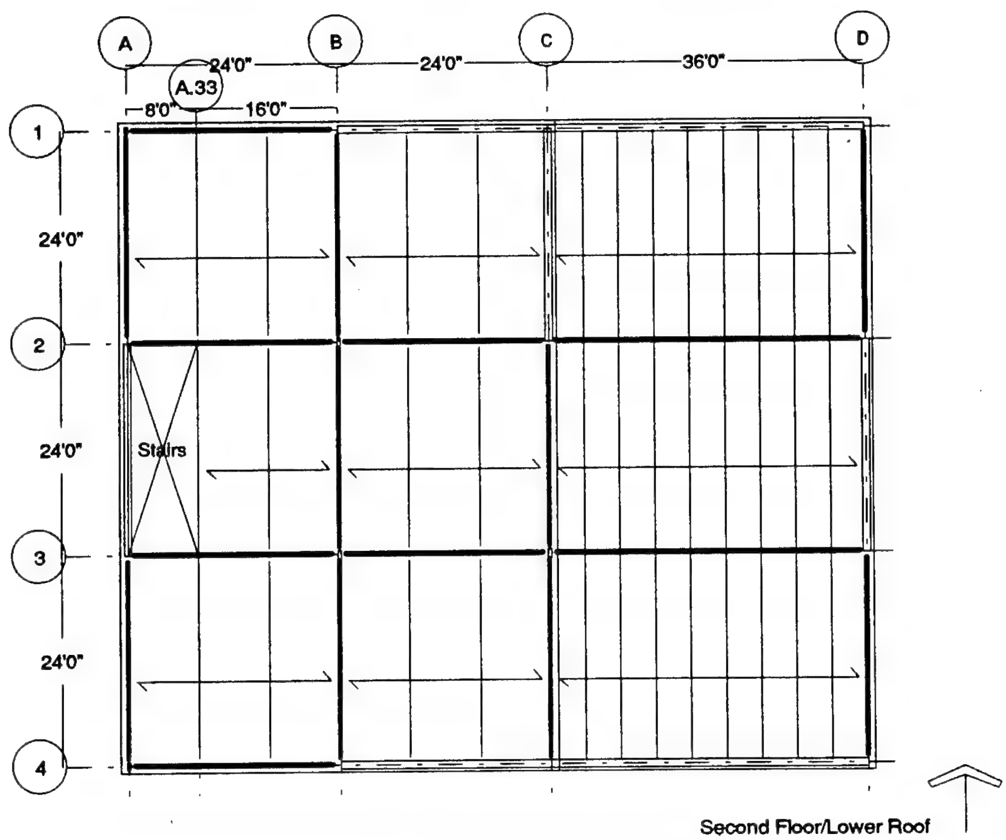
Save Wall Elements
Orientation: N-S
Start Height: 14'
End Height: 14'
Thickness: 10"
☐ All Floors
☒ Assign Dead Load
Shear Wall

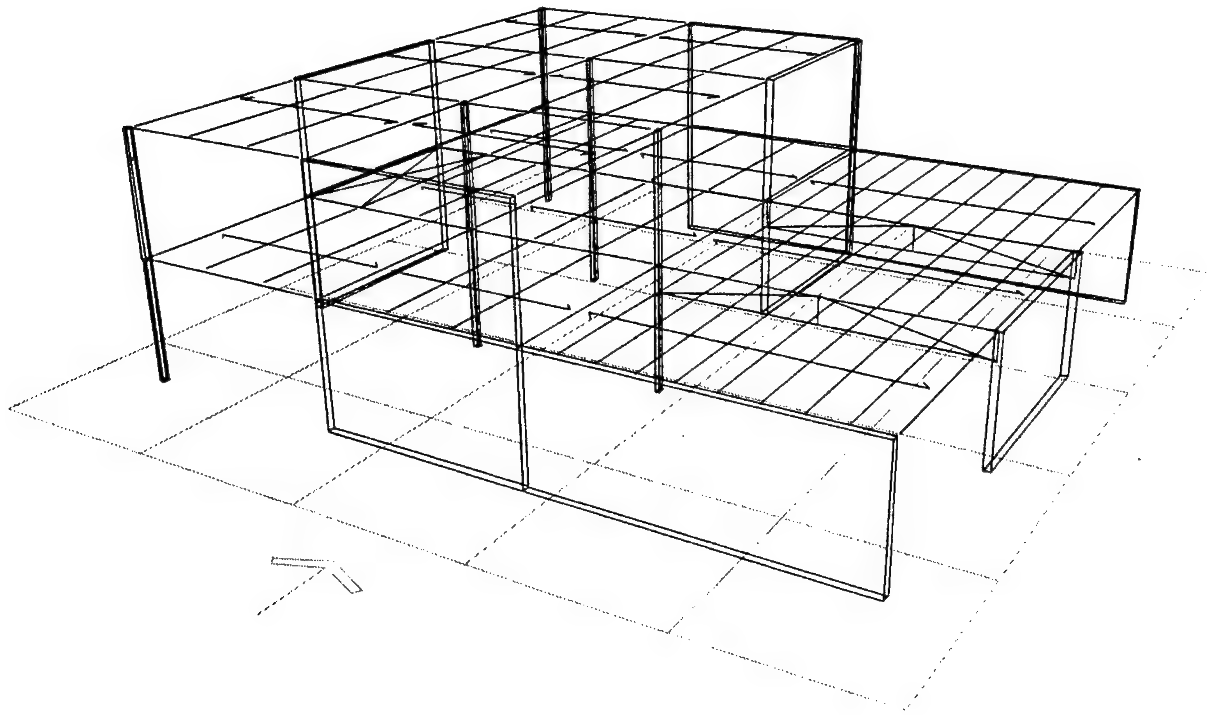
Repeat For D2-D3, C4-D4



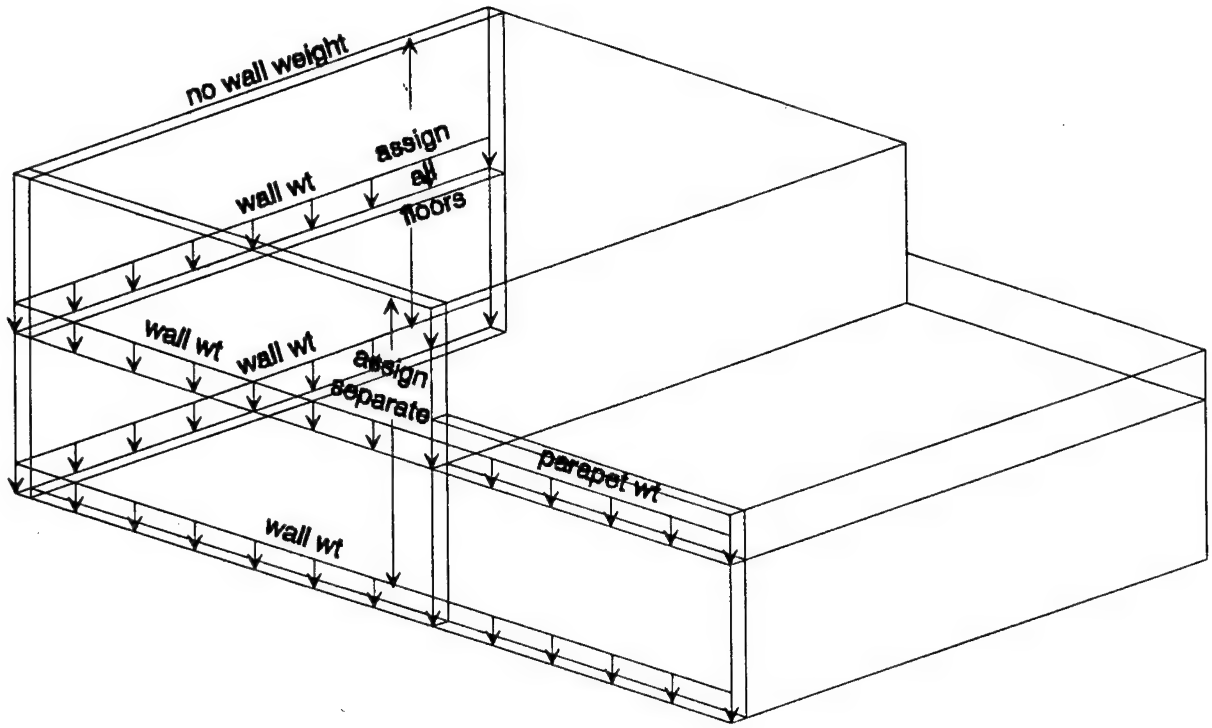

View Structure
Show Structure
☒ All Planes
Perspective (3D)
Transparent Object
End

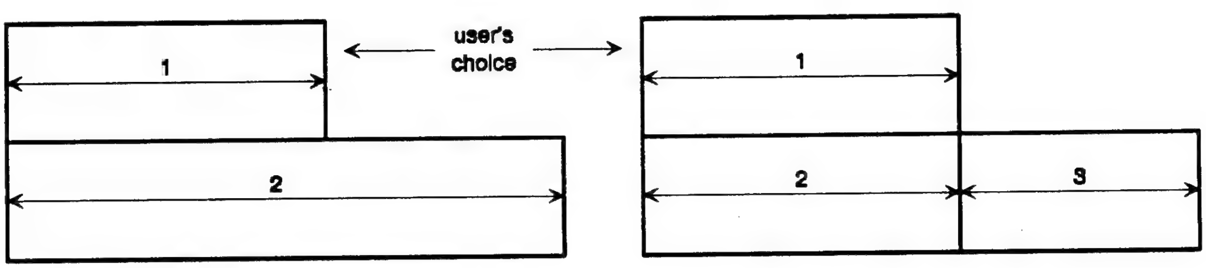

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof


A
B
C
D
24'0"
24'0"
36'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Stairs
Second Floor/Lower Roof



Assign Wall Loads Philosophy





this appproach saves memory

Assign Loads

Start

Use Loads & Design Tool Palette

Assign Live Loads

Select Second Floor/ Lower Roof Horizontal Structural Plane

Use Occupancy (LL)

Highlight: Offices 50 psf

Assign Offices 50 psf

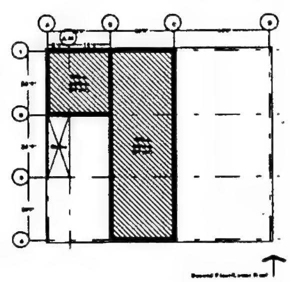
	Horizontal	Vertical
Base Point:	24'10"	10"
Point 2:	48'10"	72'10"
Length:	24'0"	72'0"

Snap To Grid

F2 Key For Keyboard Input

Assign Offices 50 psf

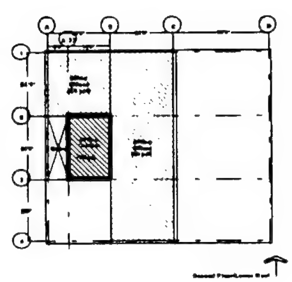
	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	24'10"	72'10"
Length:	24'0"	24'0"



Highlight: Corridor: Main 100 psf

Assign Corridor: Main 100 psf

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	24'10"	48'10"
Length:	16'0"	24'0"

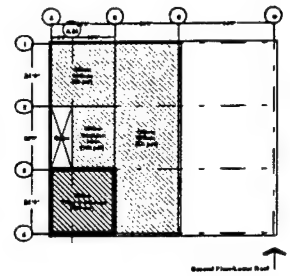


Highlight: Files & Storage 150 psf

Assign Live Loads

Assign Files & Storage 150 psf

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	24'10"
Length:	24'0"	24'0"



Stop Using Occupancy (LL)

Assign Dead Loads → **Assign Floor Loads** → **Use Floor (DL)**

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	24'10"
Length:	48'0"	24'0"

Assign Second Floor Load

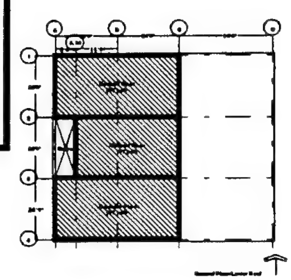
☐ Assign All Floors

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	48'10"	48'10"
Length:	40'0"	24'0"

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	48'10"	72'10"
Length:	48'0"	24'0"



Stop Using Floor (DL)

Assign Dead Loads

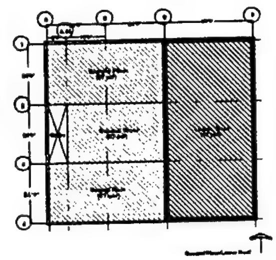
Assign Roof Loads

Use Roof (DL)

Assign Lower Roof Load

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	72'10"
Length:	36'0"	72'0"

Select Lower Roof



Stop Using Roof (DL)

Assign Exterior Wall Loads

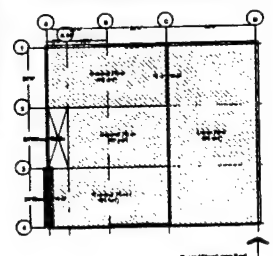
Use Wall (DL)

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	10"	24'10"
Length:	0'0"	24'0"

Select Exterior Wall



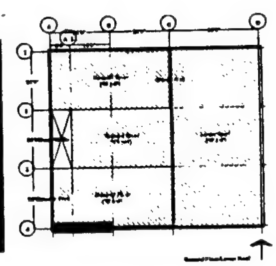
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	10"
Length:	24'0"	0'0"



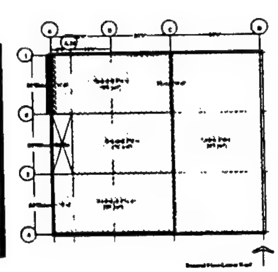
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	10"	72'10"
Length:	0'0"	24'0"



Assign Dead Loads

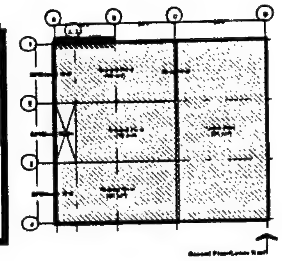
Assign Exterior Wall Loads

Wall Height
Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	24'10"	72'10"
Length:	24'0"	0'0"

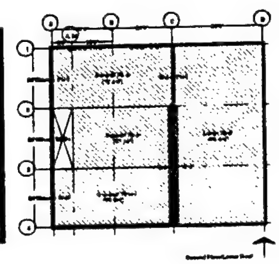


Wall Height
Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	48'10"	48'10"
Length:	0'0"	48'0"



Wall Height
Start: 14'0"
End: 14'0"

Assign Parapet Wall Loads

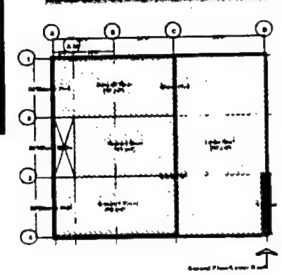
Use Wall (DL)

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	24'10"
Length:	0'0"	24'0"

Select Parapet Wall



Wall Height
Start: 4'0"
End: 4'0"

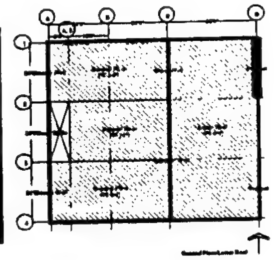
Assign Dead Loads

Assign Parapet Wall Loads

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	48'10"
Point 2:	84'10"	72'10"
Length:	0'0"	24'0"



Wall Height

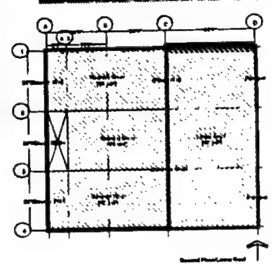
Start: 4'0"
End: 4'0"

Assign Shear Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	72'10"
Point 2:	84'10"	72'10"
Length:	36'0"	0'0"

Select Shear Wall



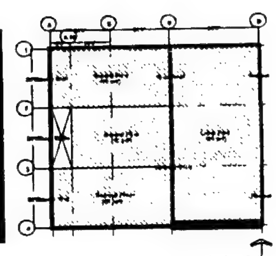
Wall Height

Start: 4'0"
End: 4'0"

Assign Shear Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	10"
Length:	36'0"	0'0"



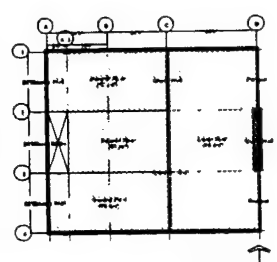
Wall Height

Start: 4'0"
End: 4'0"

Assign Shear Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	24'10"
Point 2:	84'10"	48'10"
Length:	0'0"	24'0"



Assign Dead Loads

Assign Parapet Wall Loads

Wall Height
Start: 4'0"
End: 4'0"

Stop Using Wall (DL)

Assign Upper Roof Loads

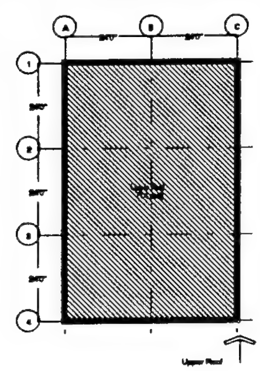
Select Upper Roof Horizontal Structural Plane

Use Roof (DL)

Assign Upper Roof Load

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	72'10"
Length:	48'0"	72'0"

Select Upper Roof



Stop Using Roof (DL)

Assign Ground Floor Wall Loads

Select Ground Floor Horizontal Structural Plane

Structural Plane Information
Name: Ground Floor

Close Structural Plane Information Dialog Window

Use Wall (DL)

Assign Dead Loads

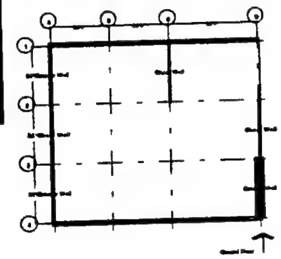
Assign Ground Floor Wall Loads

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	24'10"
Length:	0'0"	24'0"

Select Exterior Wall



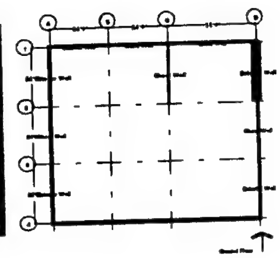
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	48'10"
Point 2:	84'10"	72'10"
Length:	0'0"	24'0"



Wall Height

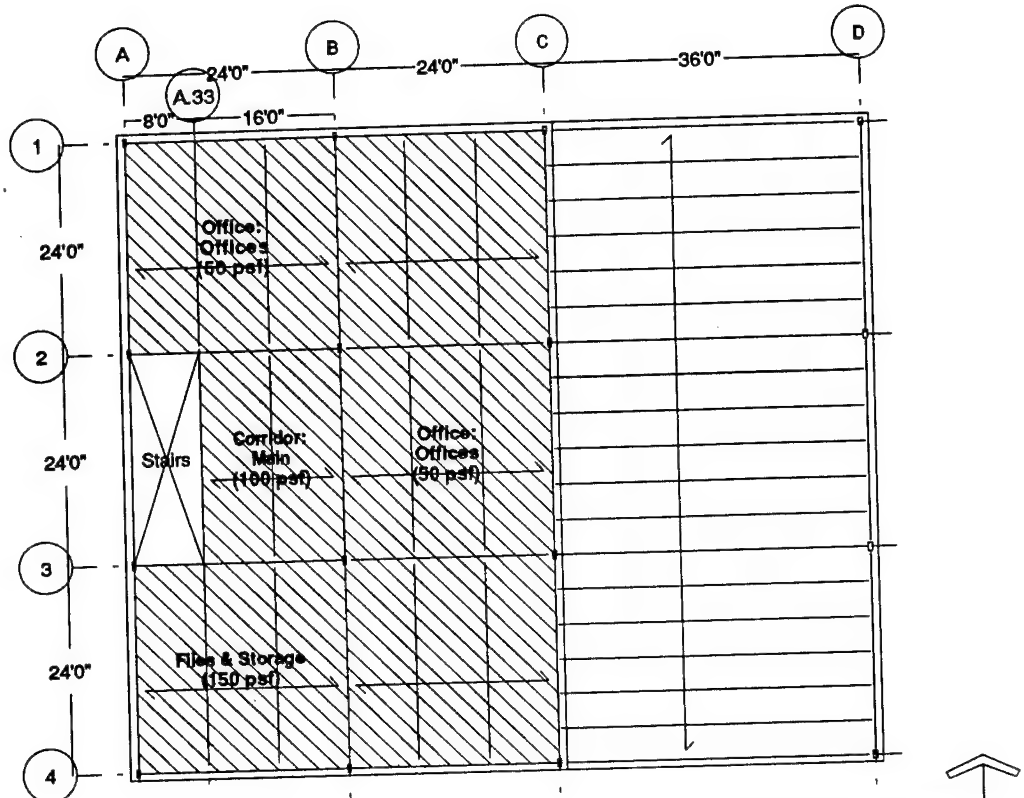
Start: 14'0"
End: 14'0"

Stop Using Wall (DL)

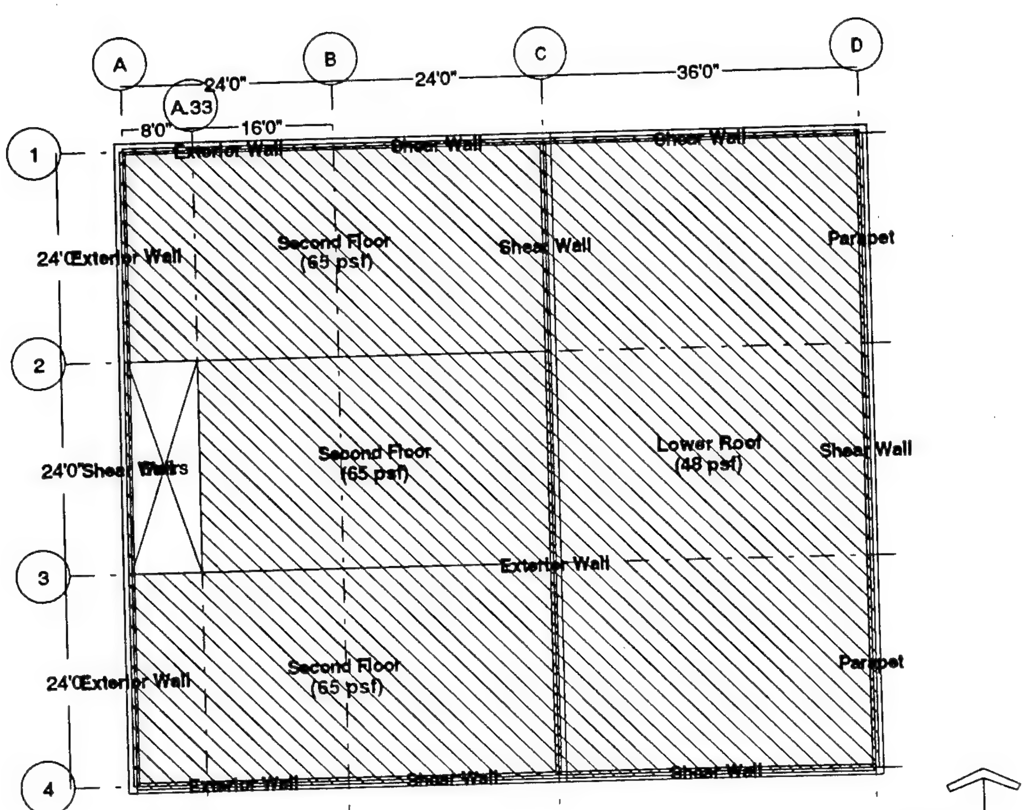
View Loads

Show Loads
None

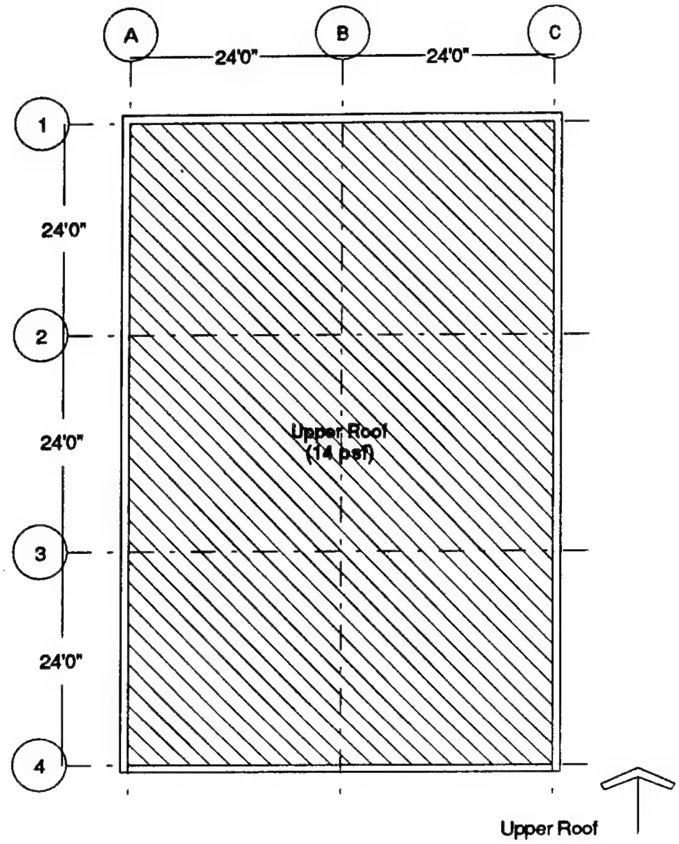
End

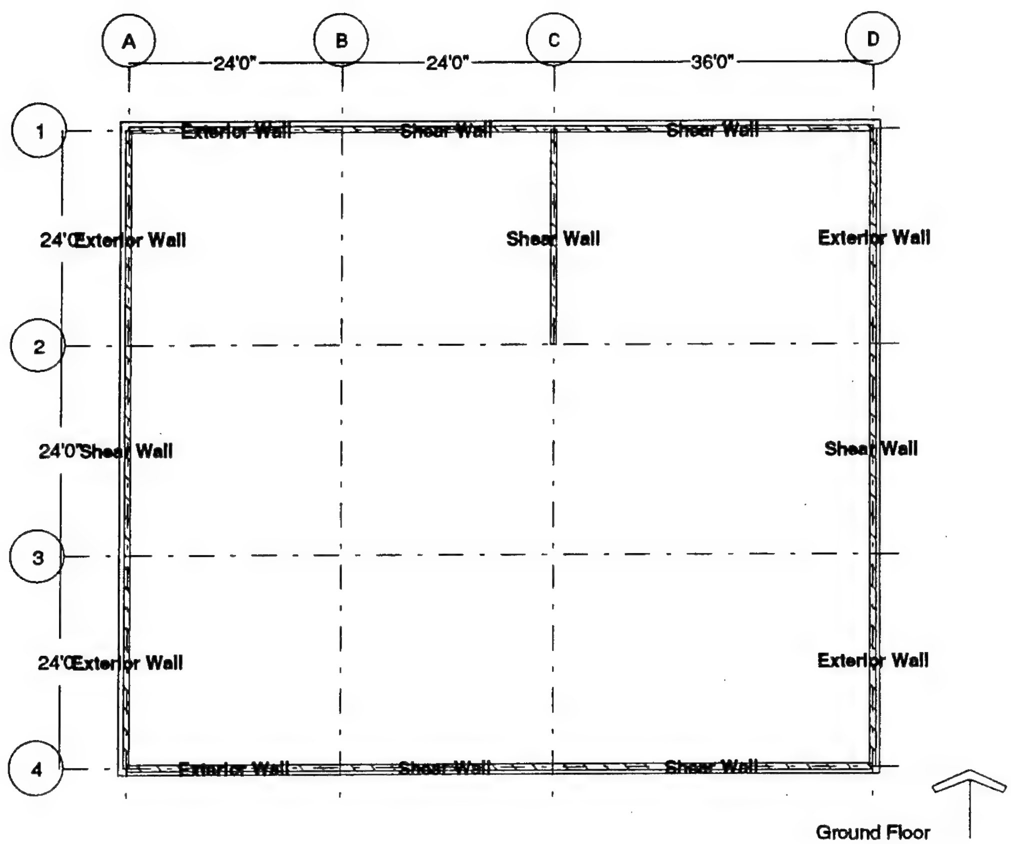


Second Floor/Lower Roof



Second Floor/Lower Roof

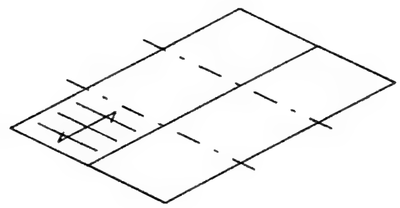

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof
(14 psf)
Upper Roof


A
B
C
D
24'0"
24'0"
36'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Shear Wall
Shear Wall
Exterior Wall
Shear Wall
Exterior Wall
Shear Wall
Shear Wall
Exterior Wall
Exterior Wall
Exterior Wall
Shear Wall
Shear Wall
Ground Floor

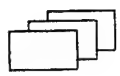
Analysis & Design Philosophy

Preliminary Analysis

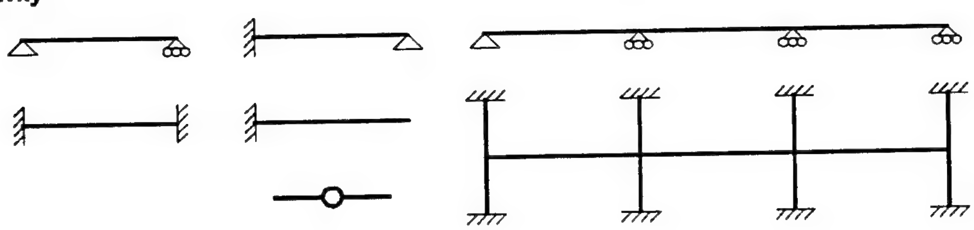
A. Select: * Material
* Load Combination
(Live Load Reduction)
* Element To Analyze



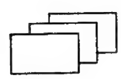
B. Review: * Attributes
* Guidelines



C. Connectivity

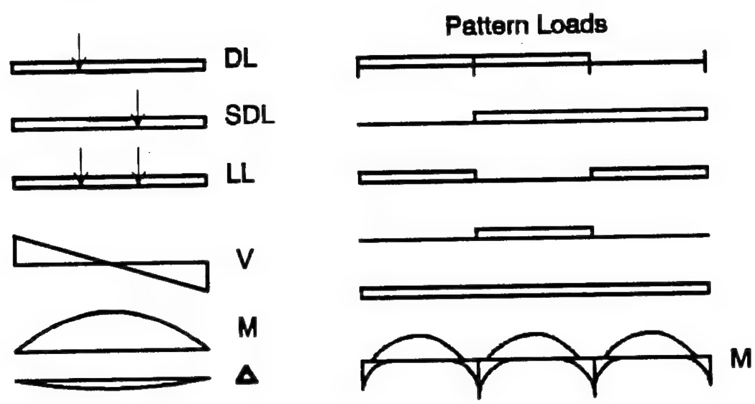


D. Self Weight Estimate * Guidelines



E. Analysis * Review Loads
* Connectivity

* Analysis Output
I = 1
E = 1
A = 1000

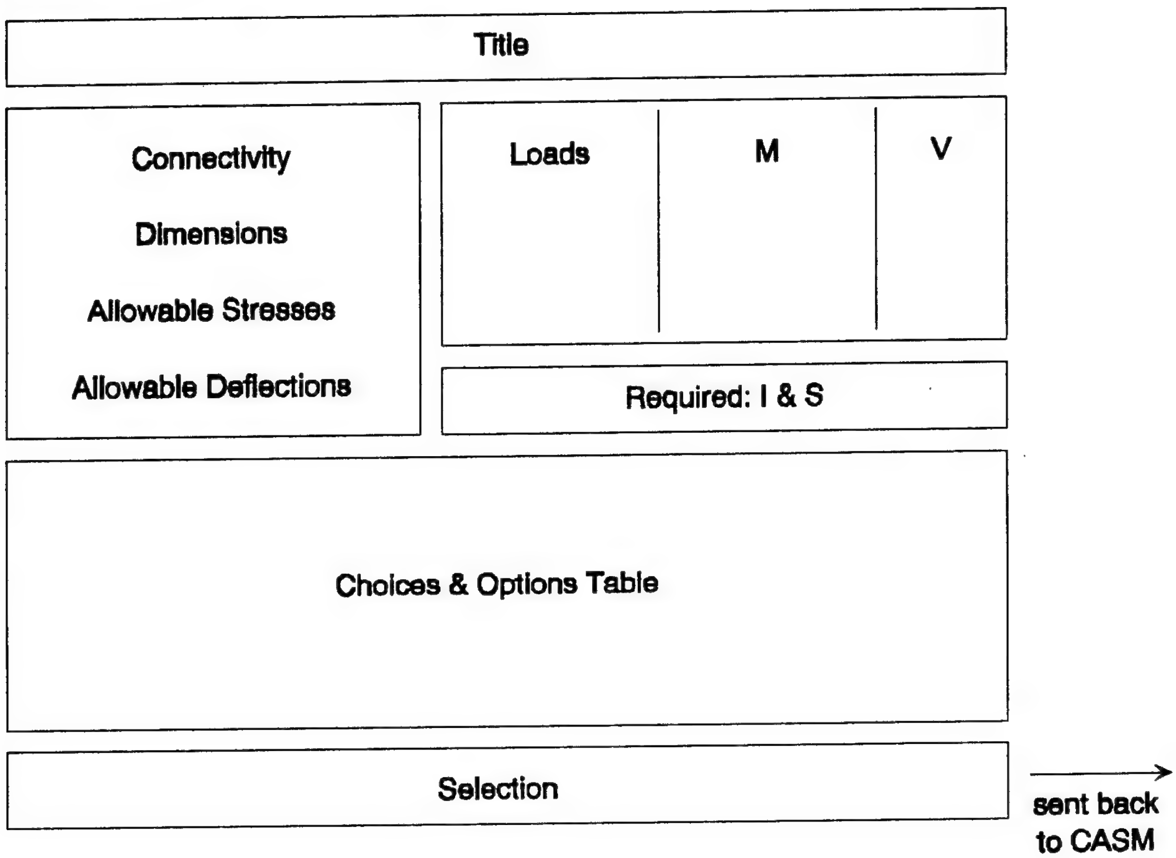


F. Re-Analysis (with real properties)

Preliminary Design

* Maximum V's, M's, R's, etc. sent to Excel

Spreadsheets



Surface Element Analysis

Start

Use Loads & Design Tool Palette

Select Upper Roof Horizontal Structural Plane

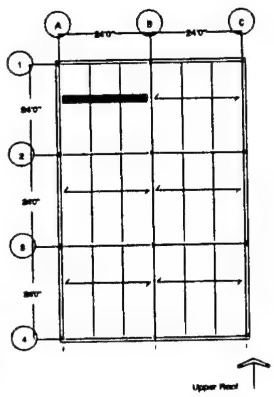
Material Concrete

Select Element To Analyze & Design

Surface One-Way C.I.P. Slab

Select A One-Way Surface Element

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis

Units: Feet & Pounds

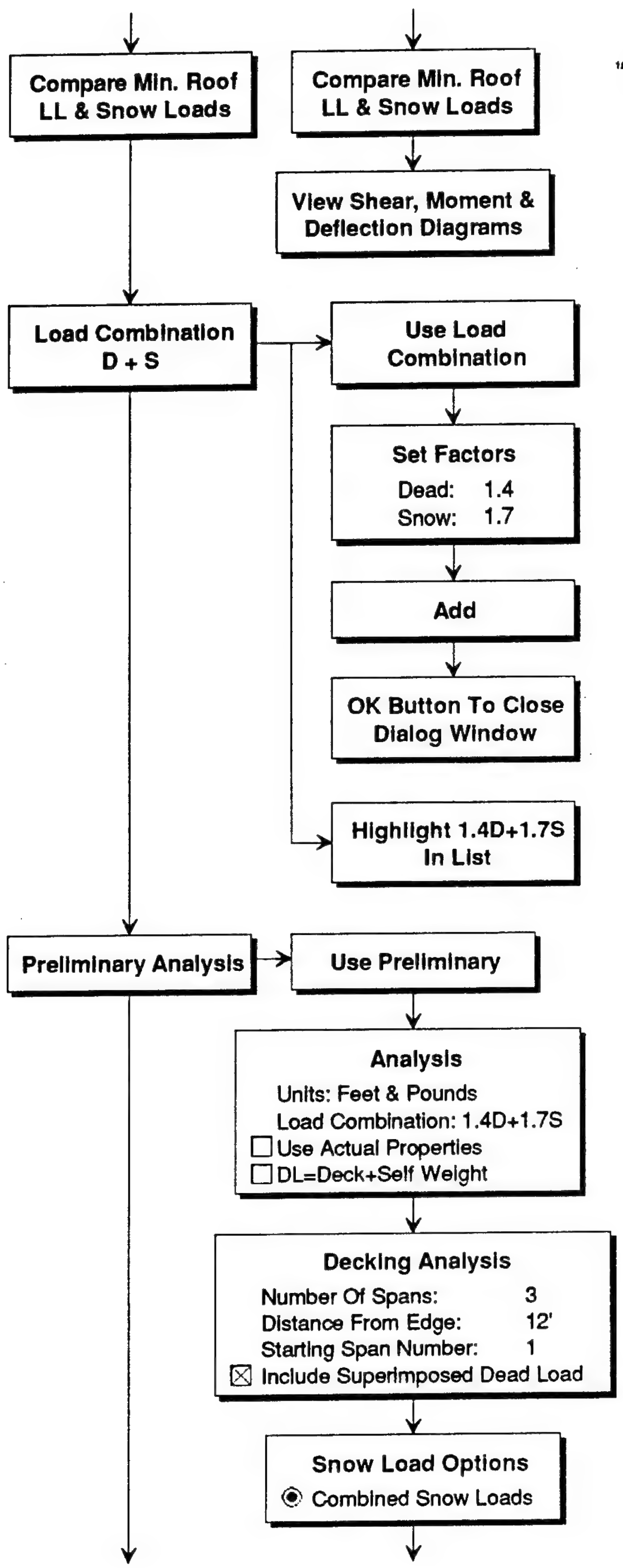
Decking Analysis

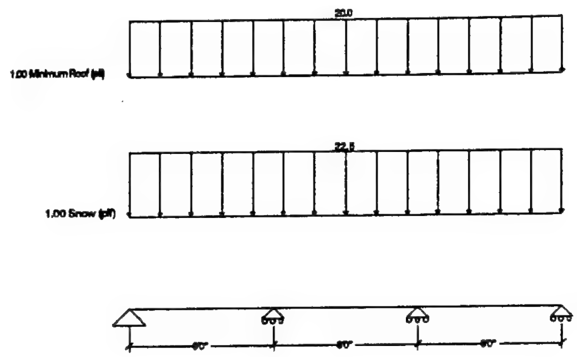
Number Of Spans:	3
Distance From Edge:	12'
Starting Span Number:	1

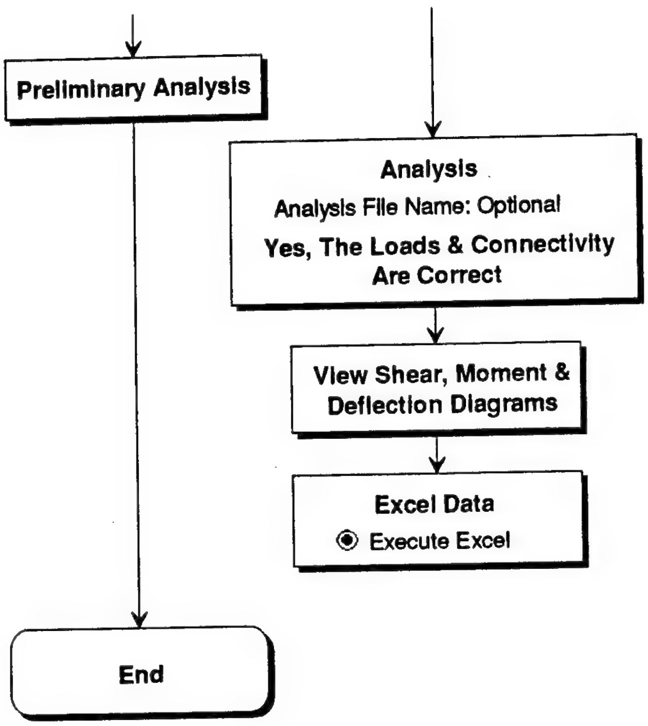
Snow Load Options

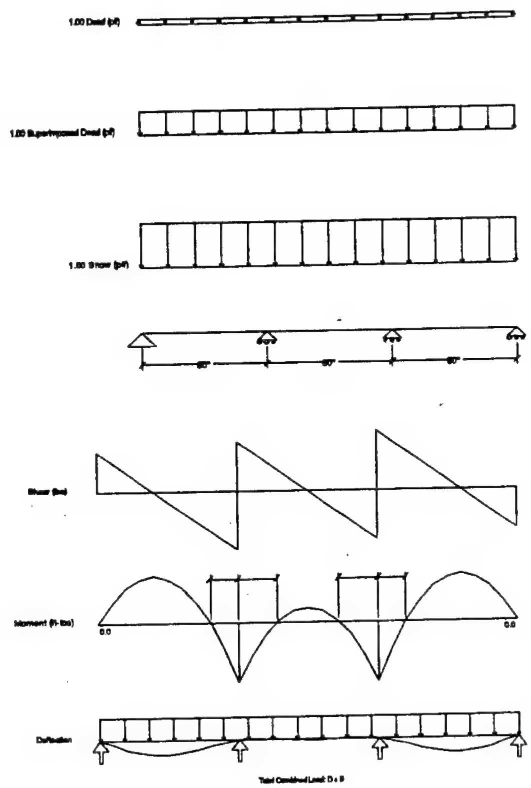
◉ Combined Snow Loads

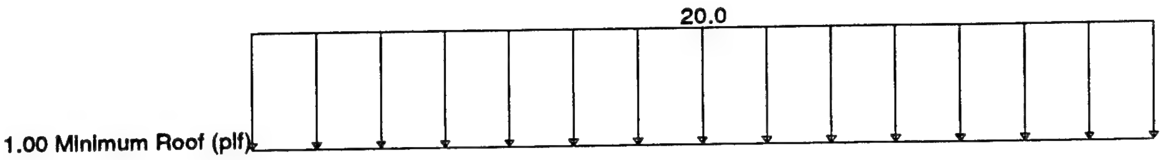
Minimum Roof (LL)

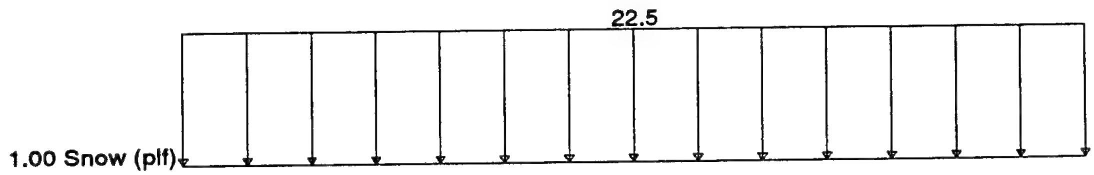

Compare Min. Roof LL & Snow Loads
Compare Min. Roof LL & Snow Loads
View Shear, Moment & Deflection Diagrams
Load Combination D + S
Use Load Combination
Set Factors
Dead: 1.4
Snow: 1.7
Add
OK Button To Close Dialog Window
Highlight 1.4D+1.7S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: 1.4D+1.7S
Use Actual Properties
DL=Deck+Self Weight
Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1
Include Superimposed Dead Load
Snow Load Options
Combined Snow Loads

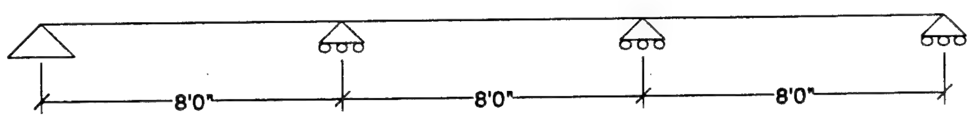

20.0
1.00 Minimum Roof (plf)
22.5
1.00 Snow (plf)


Preliminary Analysis
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

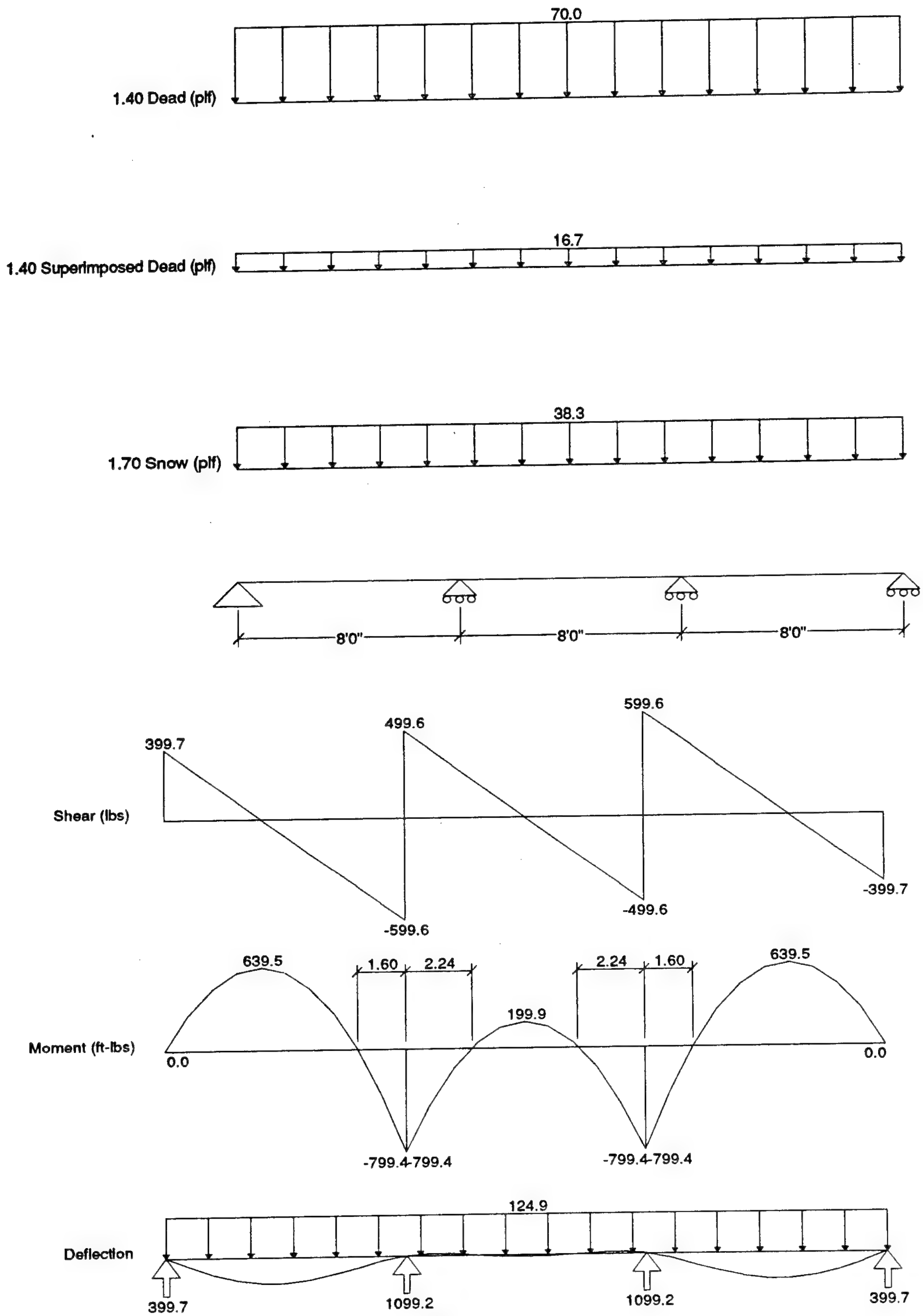






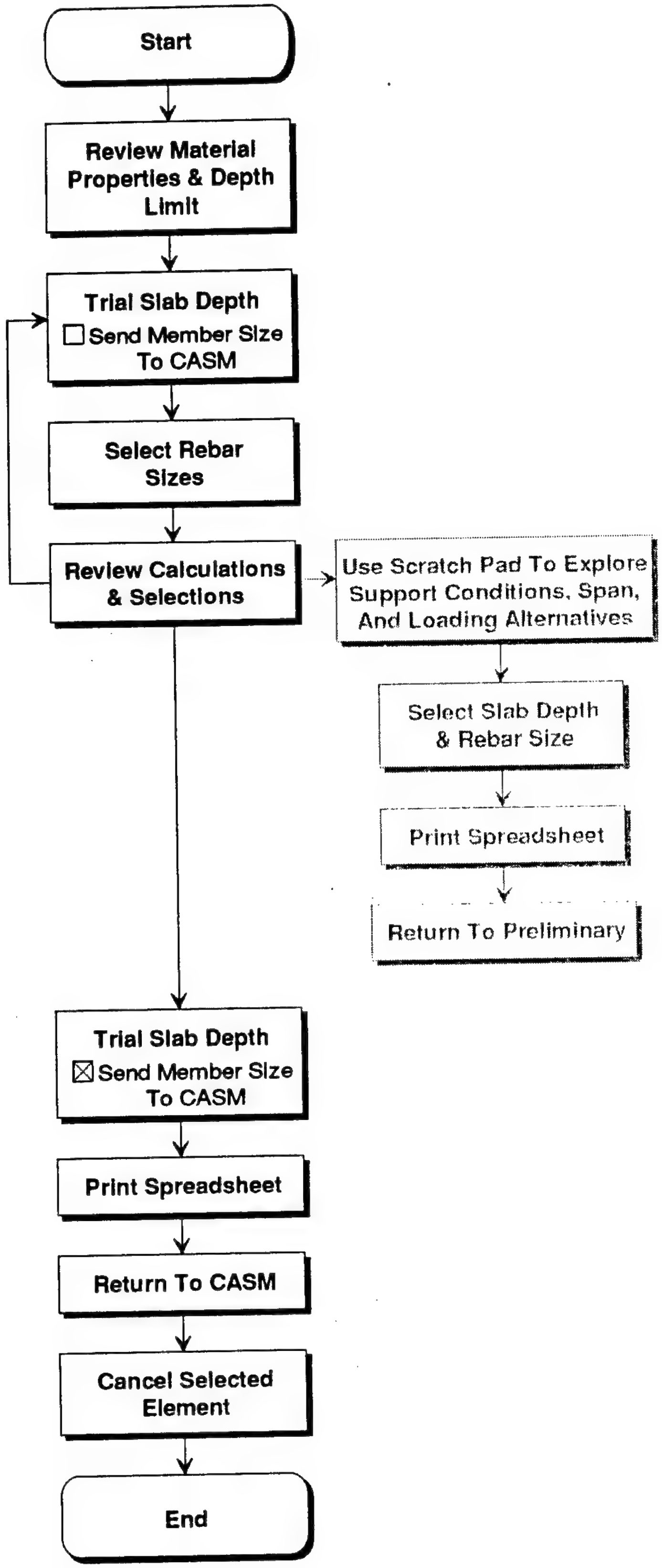



```
Project      : Office Building - Scheme C
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Tue Aug 30, 1994   12:08 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 24.0 sqft
Roof Slope      (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: 1.4D + 1.7S

Concrete Slab Design



CONCRETE SLAB PRELIMINARY SELECTION

Project: Office Building - Scheme C	**Date: Aug 30, 1994**
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis

Load Combination: 1.4D + 1.7S

			Factored Moments (k-ft)			Fact. Reactions	
Member ID:		Load Type	Left	Mid	Right	Left(k)	Right(k)
Connectivity:	Beam (Left)	Dead	0.4	0.4	0.4	0.3	0.3
	Beam (Right)	Sup Dead	0.1	0.1	0.1	0.1	0.1
Slab Span:	8.0 ft	Live					
Trib Width=	12.0 in	Lmin Roof					
Depth Limit=	8.0 in. max	Snow	0.2	0.2	0.2	0.2	0.2
Concrete F'c=	4.0 ksi	Wind					
Concrete Wt=	145 pcf						
Steel Fy=	60.0 ksi	Summary	0.8	0.6	0.8	0.6	0.6

CASM Preliminary Slab Thickness/Values:

ACI Preliminary Dimensions:				Design Data:	Rebar Ratios:	
ACI Depth: L/ 28.0 =	3.4 in			Bending phi(¢)= 0.90	pmax=	2.14 %
Trial Depth=	4.00 in	Span=	3	beta(ß)= 0.85	1/2pmax=	1.07 %
Cover: Top=	0.75 in	Btm=	0.75 in	m= 17.6	pmin=	0.33 %
d'=	1.00 in	d=	3.00 in	Ru= 581 psi		

CASM Preliminary Slab Reinforcement:

		Left end		Midspan		Right end			
		Reqd	Select	Reqd	Select	Reqd	Select		
Mu (kf)		0.80	1.74	0.64	1.74	0.80	1.74	Shear Capacity:	
Ru (psi)		99	215	79	215	99	215	¢Vc=	3.9 k
Reqd p (%)		0.18	0.37	0.15	0.37	0.18	0.37		
Reqd As (sq in.)		0.07	0.13	0.05	0.13	0.07	0.13	Shrinkage/Temp Reinforcement	
Rebar &	#4	18.00		18.00		18.00			
Spacing	#5	18.00		18.00		18.00		Rqd As=	0.09
Options:	#6	18.00		18.00		18.00		Selected	
Selected Bar Size:		#4		#4		#4		Bar Size=	#3
Selected Spacing:		18 in		18 in		18 in		Spacing=	15 in
As (sq in/ft)= :		0.13		0.13		0.13		As=	0.09

4." slab w/ #4@18 in **Quantities:**

Depth= 4.00 in	Conc Vol= .012 cy/sf	Rebar Wgt = .0005 tons/sf

Notes:

1. ACI 318-89 Strength Design used for sizing member.

Narrowly Spaced Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

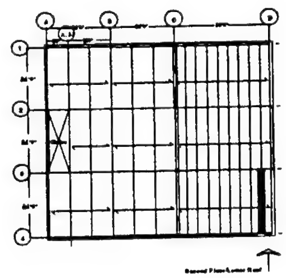
Material Steel

Select Element To Analyze & Design

Linear Narrowly Spaced Open-Web Joists-K

Select A Narrowly Spaced Element Near A Corner

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

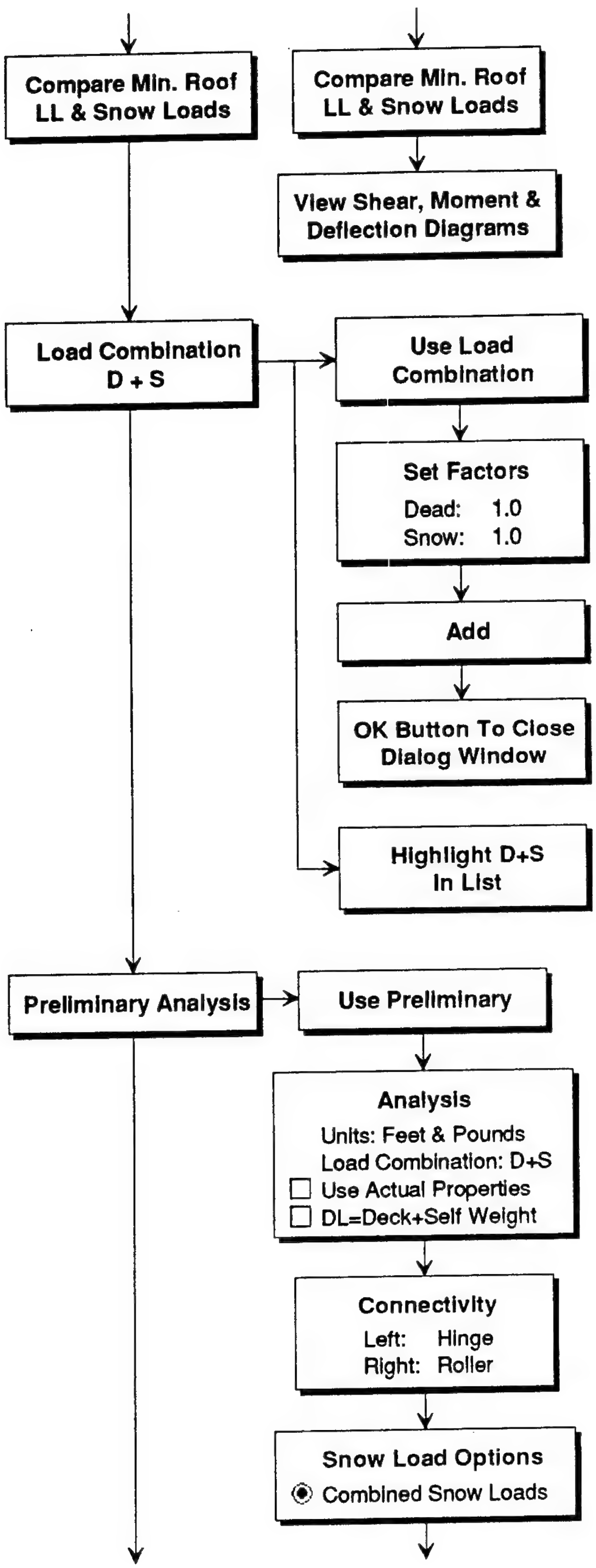
Use Compare Min. Roof LL & Snow Loads

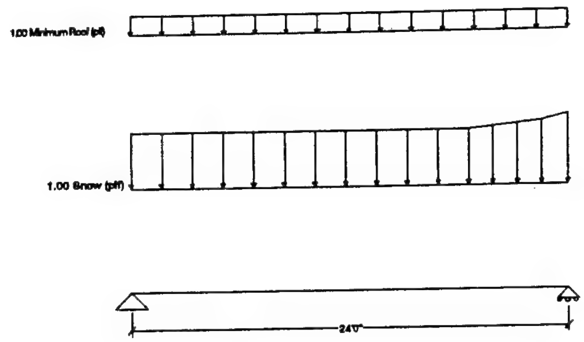
Analysis
Units: Feet & Pounds

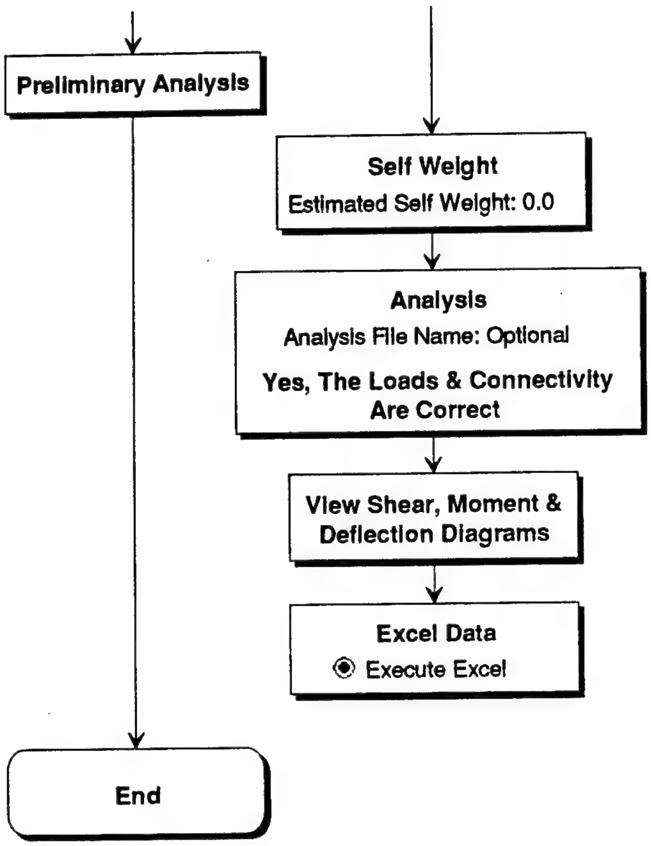
Connectivity
Left: Hinge
Right: Roller

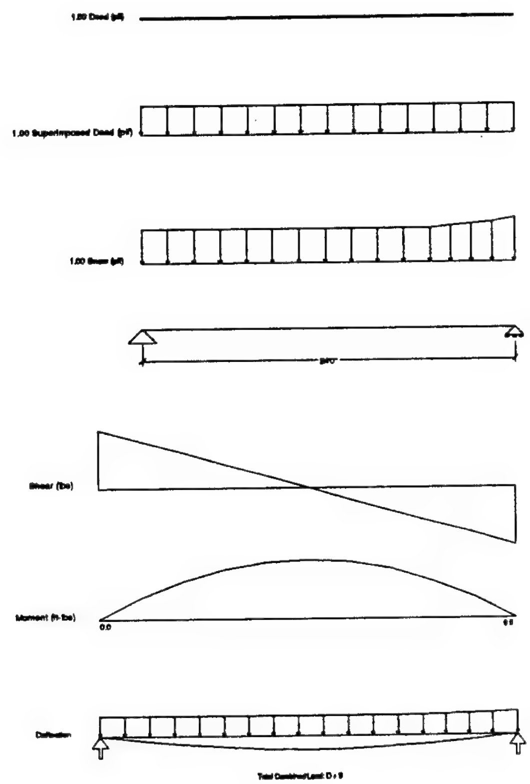
Snow Load Options
◉ Combined Snow Loads

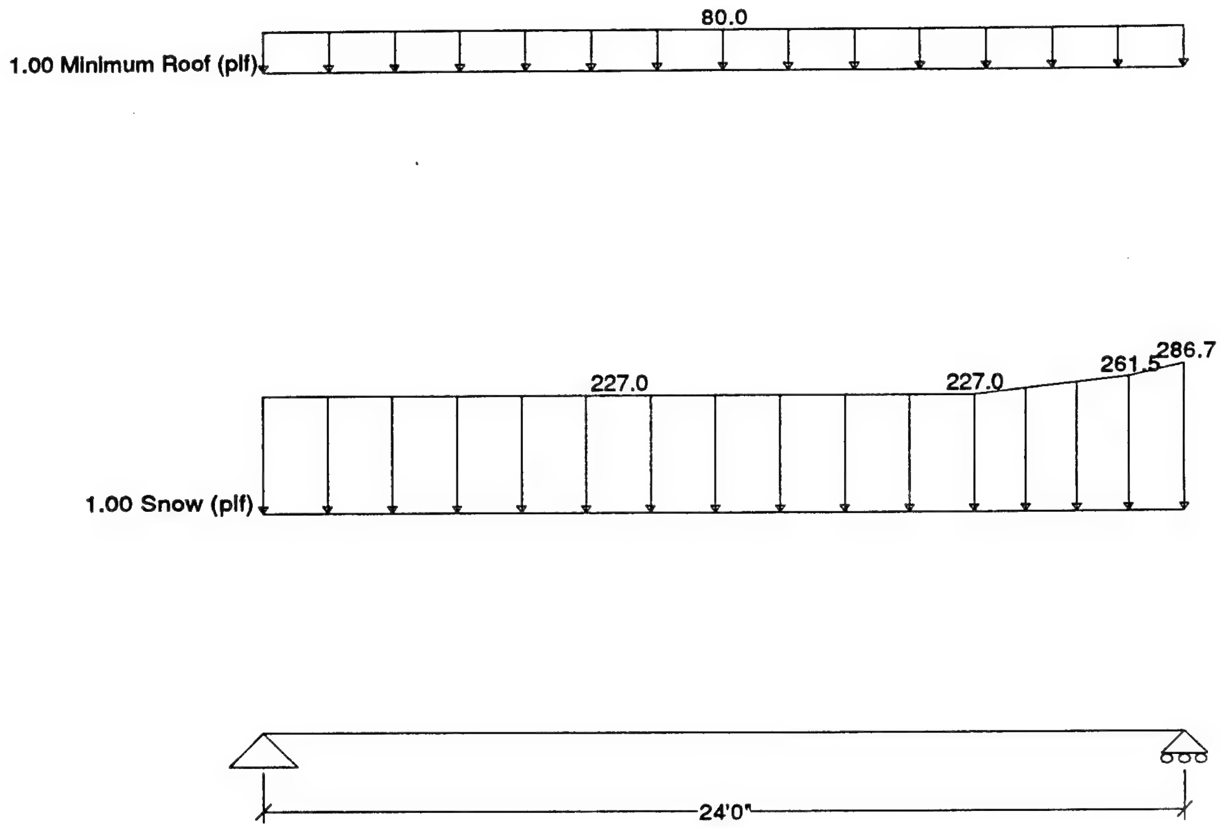
Minimum Roof (LL)


Compare Min. Roof
LL & Snow Loads
Compare Min. Roof
LL & Snow Loads
View Shear, Moment &
Deflection Diagrams
Load Combination
D + S
Use Load
Combination
Set Factors
Dead: 1.0
Snow: 1.0
Add
OK Button To Close
Dialog Window
Highlight D+S
In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+S
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Snow Load Options
Combined Snow Loads

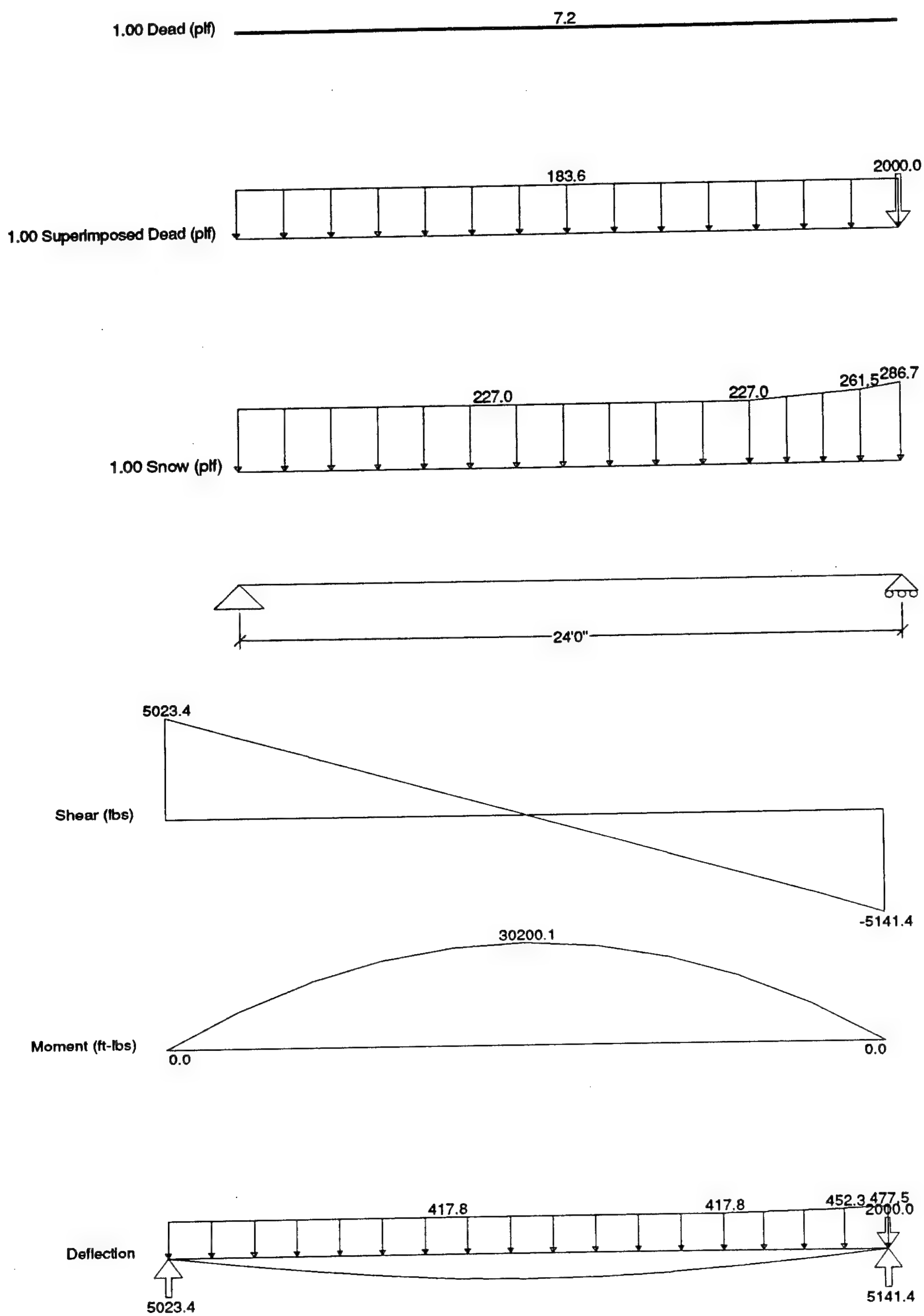

1.00 Minimum Roof (plf)
1.00 Snow (plf)
24'0"


Preliminary Analysis
Self Weight
Estimated Self Weight: 0.0
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End






```
Project      : Office Building - Scheme C
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994   2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At)  : 96.0 sqft
Roof Slope      (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************* I N P U T *********************************

Office Building - Scheme C -- 1.00 Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-7.20	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	8.640	3.456	0.000	8.640	-3.456

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

******************************* O U T P U T *******************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-597.1968
2	0.0000	-16872.4818	-563.7538
3	0.0000	-31921.8411	-472.9799
4	0.0000	-43703.3396	-339.2078
5	0.0000	-51185.0211	-176.7703
6	0.0000	-53747.7120	0.0000
7	0.0000	-51185.0211	176.7703
8	0.0000	-43703.3396	339.2078
9	0.0000	-31921.8411	472.9799
10	0.0000	-16872.4818	563.7538
11	0.0000	0.0000	597.1968

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	86.400	0.000	0.000	-69.120	186.624
2	0.000	69.120	-186.624	0.000	-51.840	331.776
3	0.000	51.840	-331.776	0.000	-34.560	435.456
4	0.000	34.560	-435.456	0.000	-17.280	497.664
5	0.000	17.280	-497.664	0.000	0.000	518.400
6	0.000	0.000	-518.400	0.000	17.280	497.664
7	0.000	-17.280	-497.664	0.000	34.560	435.456
8	0.000	-34.560	-435.456	0.000	51.840	331.776
9	0.000	-51.840	-331.776	0.000	69.120	186.624
10	0.000	-69.120	-186.624	0.000	86.400	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	86.400	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	86.400	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************* I N P U T *********************************

Office Building - Scheme C -- 1.00 Superimposed Dead Load

```
NUMBER OF ELEMENTS              =   10
NUMBER OF NODAL POINTS          =   11
NUMBER OF MATERIALS             =    1
NUMBER OF ELEMENT TYPES         =    1
NUMBER OF ELASTIC SUPPORT TYPES =    0
NUMBER OF FIXED END FORCE TYPES =    1
```

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-183.60	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	220.320	88.128	0.000	220.320	-88.128

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			
NODE	CODE	X	Y	X	Y	Z	ELASTIC SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

```
******************************** O U T P U T ******************************
```

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-15228.5184
2	0.0000	-430248.2847	-14375.7214
3	0.0000	-814006.9483	-12060.9866
4	0.0000	-1114435.1593	-8649.7985
5	0.0000	-1305218.0378	-4507.6414
6	0.0000	-1370566.6560	0.0000
7	0.0000	-1305218.0378	4507.6414
8	0.0000	-1114435.1593	8649.7985
9	0.0000	-814006.9483	12060.9866
10	0.0000	-430248.2847	14375.7214
11	0.0000	0.0000	15228.5184

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2203.200	0.000	0.000	-1762.560	4758.912
2	0.000	1762.560	-4758.912	0.000	-1321.920	8460.288
3	0.000	1321.920	-8460.288	0.000	-881.280	11104.128
4	0.000	881.280	-11104.128	0.000	-440.640	12690.432
5	0.000	440.640	-12690.432	0.000	0.000	13219.200
6	0.000	0.000	-13219.200	0.000	440.640	12690.432
7	0.000	-440.640	-12690.432	0.000	881.280	11104.128
8	0.000	-881.280	-11104.128	0.000	1321.920	8460.288
9	0.000	-1321.920	-8460.288	0.000	1762.560	4758.912
10	0.000	-1762.560	-4758.912	0.000	2203.200	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2203.200	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2203.200	0.000

```
**PROBLEMS COMPLETED**


*******************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
*******************************************


2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994  4:20 PM


********************************* I N P U T *********************************


Office Building - Scheme C -- 1.00 Snow Load


NUMBER OF ELEMENTS              =   10
NUMBER OF NODAL POINTS          =   11
NUMBER OF MATERIALS             =    1
NUMBER OF ELEMENT TYPES         =    1
NUMBER OF ELASTIC SUPPORT TYPES =    0
NUMBER OF FIXED END FORCE TYPES =    4
```

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-226.99	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	272.386	108.954	0.000	272.386	-108.954
2	0.000	272.450	109.002	0.000	274.208	-109.265
3	0.000	286.687	115.669	0.000	296.627	-117.657
4	0.000	312.831	126.477	0.000	329.404	-129.853

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-18962.7216
2	0.0000	-535784.4750	-17904.2668
3	0.0000	-1013855.3129	-15030.1394
4	0.0000	-1388427.8640	-10792.1951
5	0.0000	-1626730.9187	-5642.2892
6	0.0000	-1709006.7080	-32.2776
7	0.0000	-1628510.9034	5585.9844
8	0.0000	-1391512.6167	10760.6411
9	0.0000	-1017294.4159	15039.8270
10	0.0000	-538185.6478	17967.1701
11	0.0000	0.0000	19058.1368

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2733.806	0.000	0.000	-2189.034	5907.408
2	0.000	2189.034	-5907.408	0.000	-1644.262	10507.364
3	0.000	1644.262	-10507.364	0.000	-1099.491	13799.868
4	0.000	1099.491	-13799.868	0.000	-554.719	15784.919
5	0.000	554.719	-15784.919	0.000	-9.947	16462.518
6	0.000	9.947	-16462.518	0.000	534.825	15832.664
7	0.000	-534.825	-15832.664	0.000	1079.597	13895.357
8	0.000	-1079.597	-13895.357	0.000	1626.255	10650.183
9	0.000	-1626.255	-10650.183	0.000	2209.569	6057.134
10	0.000	-2209.569	-6057.134	0.000	2851.803	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2733.806	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2851.803	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

******************************** I N P U T ********************************

Office Building - Scheme C -- Total Combined Load: D + S

NUMBER OF ELEMENTS = 10
NUMBER OF NODAL POINTS = 11
NUMBER OF MATERIALS = 1
NUMBER OF ELEMENT TYPES = 1
NUMBER OF ELASTIC SUPPORT TYPES = 0
NUMBER OF FIXED END FORCE TYPES = 4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-417.79	0.00		2.40
2	UNIFRM	2.40	-190.80	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	UNIFRM	2.40	-190.80	0.00		2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	UNIFRM	2.40	-190.80	0.00		2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	501.346	200.538	0.000	501.346	-200.538
2	0.000	501.410	200.586	0.000	503.168	-200.849
3	0.000	515.647	207.253	0.000	525.587	-209.241
4	0.000	541.791	218.061	0.000	558.364	-221.437

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-34788.4368
2	0.0000	-982905.2414	-32843.7420
3	0.0000	-1859784.1024	-27564.1059
4	0.0000	-2546566.3629	-19781.2013
5	0.0000	-2983133.9776	-10326.7009
6	0.0000	-3133321.0760	-32.2776
7	0.0000	-2984913.9624	10270.3961
8	0.0000	-2549651.1156	19749.6473
9	0.0000	-1863223.2053	27573.7935
10	0.0000	-985306.4142	32906.6452
11	0.0000	0.0000	34883.8520

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	5023.406	0.000	0.000	-4020.714	10852.944
2	0.000	4020.714	-10852.944	0.000	-3018.022	19299.428
3	0.000	3018.022	-19299.428	0.000	-2015.331	25339.452
4	0.000	2015.331	-25339.452	0.000	-1012.639	28973.015
5	0.000	1012.639	-28973.015	0.000	-9.947	30200.118
6	0.000	9.947	-30200.118	0.000	992.745	29020.760
7	0.000	-992.745	-29020.760	0.000	1995.437	25434.941
8	0.000	-1995.437	-25434.941	0.000	3000.015	19442.247
9	0.000	-3000.015	-19442.247	0.000	4041.249	11002.670
10	0.000	-4041.249	-11002.670	0.000	5141.403	0.000

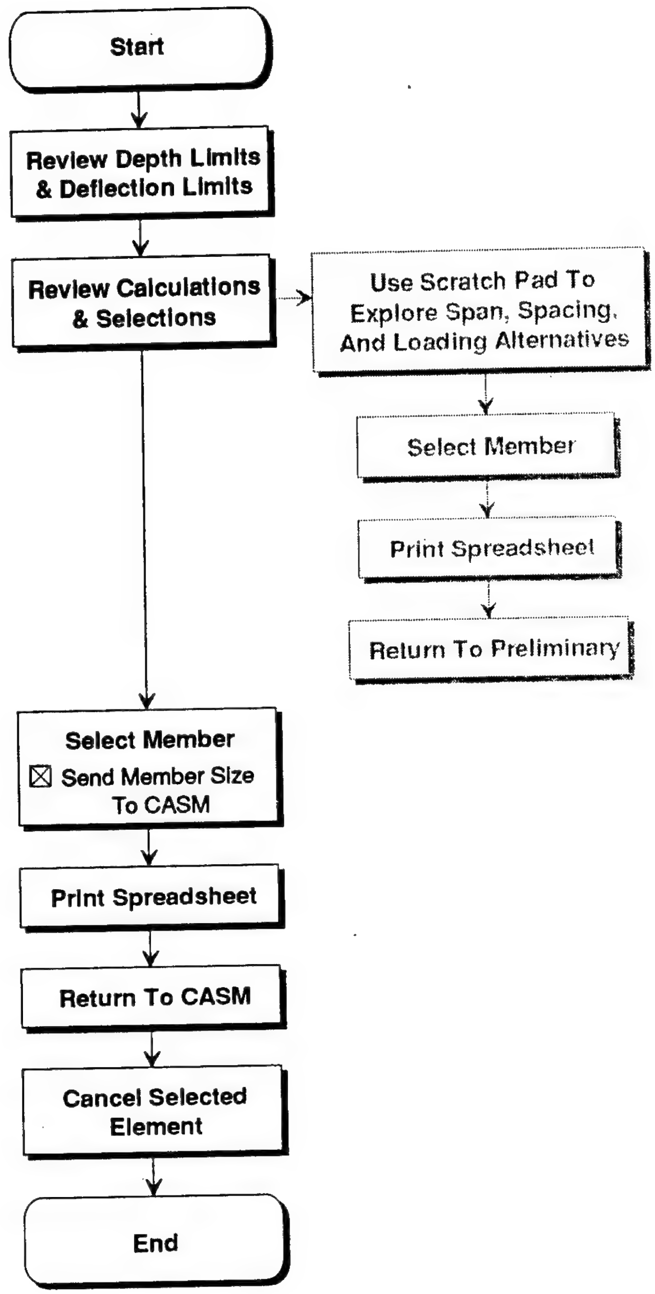
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	5023.406	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	5141.403	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme C Location: Radford AAP	Date: Sep 01, 1994 Engr:

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connection: Hinge (Left)
Roller (Right)
Span: 24.0 ft
Spacing: 48.0 in
Depth Limit= 30.0 in. max
Fy= 50.0 ksi
Fb= 30.0 ksi
E = 29,000 ksi
Live Defl= L/360= 0.80 in
Total Defl= L/240= 1.20 in

Ponding Check: NO

Load Combination D + S

LoadType	Factored Moment (ft-lb) Left	Mid	Right	Factored Reaction Left(lb)	Right(lb)
Dead		518		86	86
Sup Dead		13,219		2,203	2,203
Live					
Lmin Roof					
Snow		16,463		2,734	2,852
Wind					
Summary		30,200		5,023	5,141

Moment EUL:	Total Ld= 419 plf Live Ld= 229 plf	Reaction EUL:	Total Ld= 428 plf Live Ld= 238 plf

CASM Joist Selection Table: (joist capacities)

Joist Size	Spacing (in)	Total Ld(plf)	Live Ld(plf)	Mmax (ftlb)	Rmax (lb)	Live Ld Defl(in)	Total Ld Defl(in)	Ponding	Jst Wgt (plf)
20K4	48.0	430	353	30,960	5,160	0.54	0.98		7.6
18K5	48.0	434	318	31,248	5,208	0.61	1.10		7.7
22K4	48.0	475	431	34,200	5,700	0.45	0.81		8.0
20K5	48.0	485	396	34,920	5,820	0.49	0.88		8.2

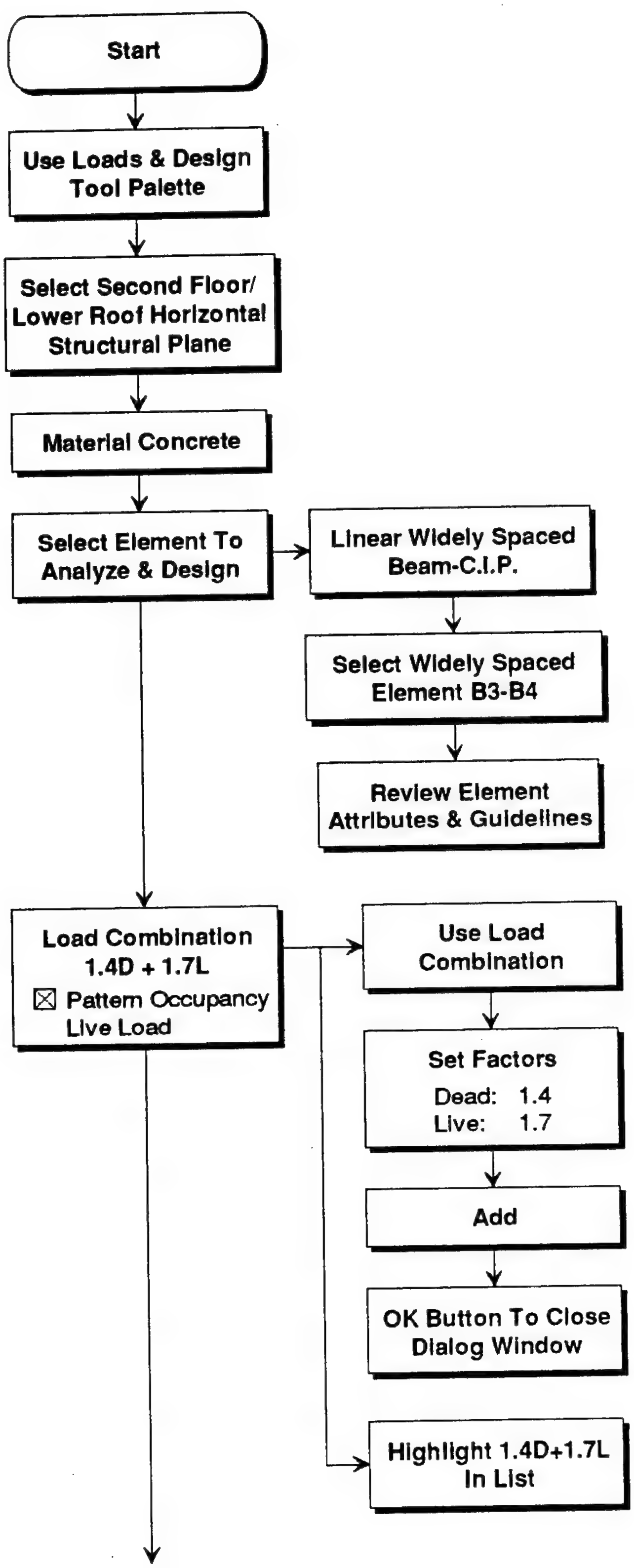
CASM Bar Joist Selection:

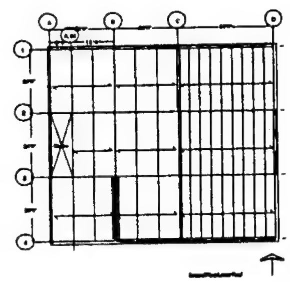
Joist Size:	20K4	Span:	24.0 ft	Spacing:	48 in	TL defl:	0.98 in	LL defl:	0.54 in
Wgt(tons):	0.09	Mmax:	30,960	Rmax:	5,160	Total Ld:	430 plf	Live Ld:	353 plf

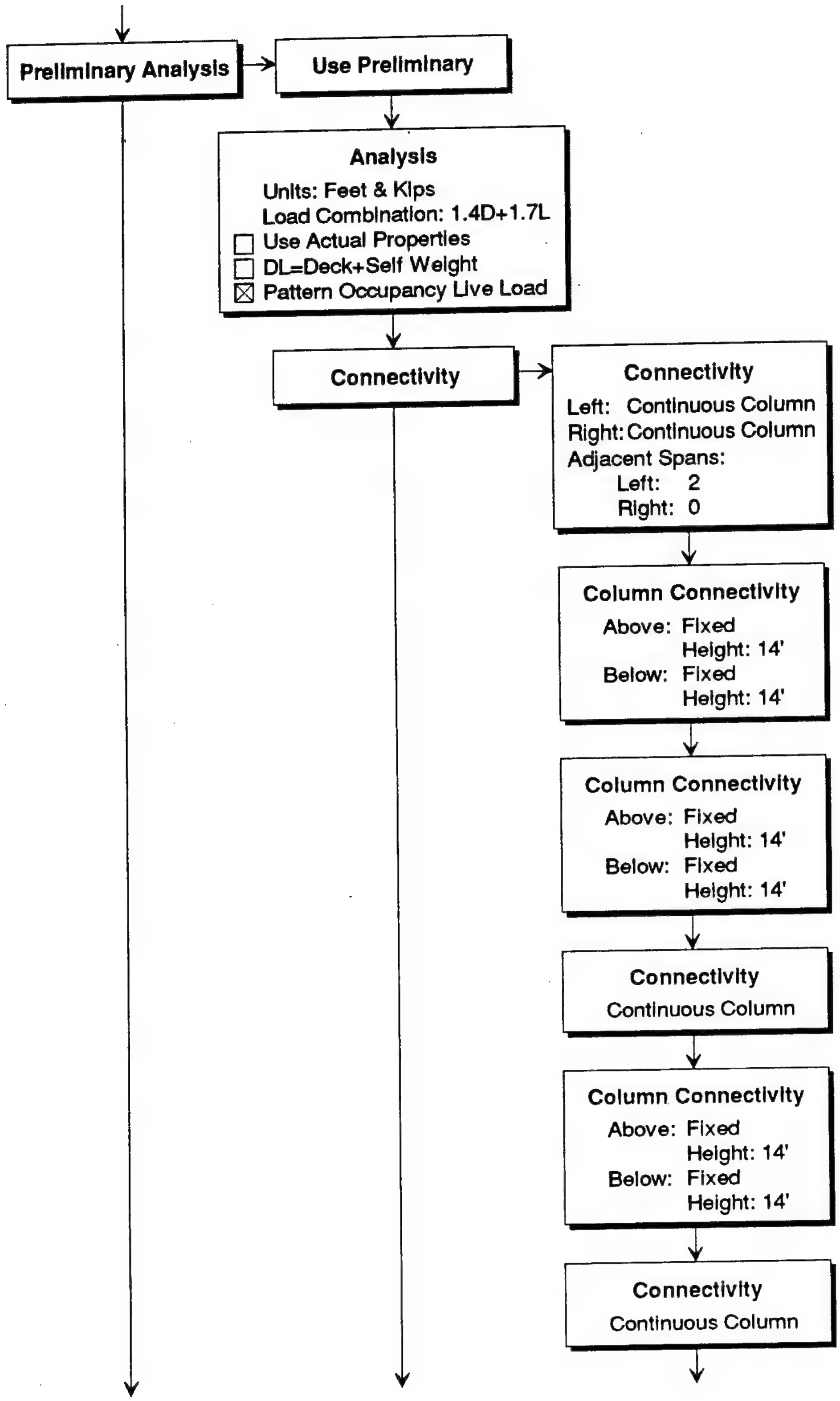
NOTES:

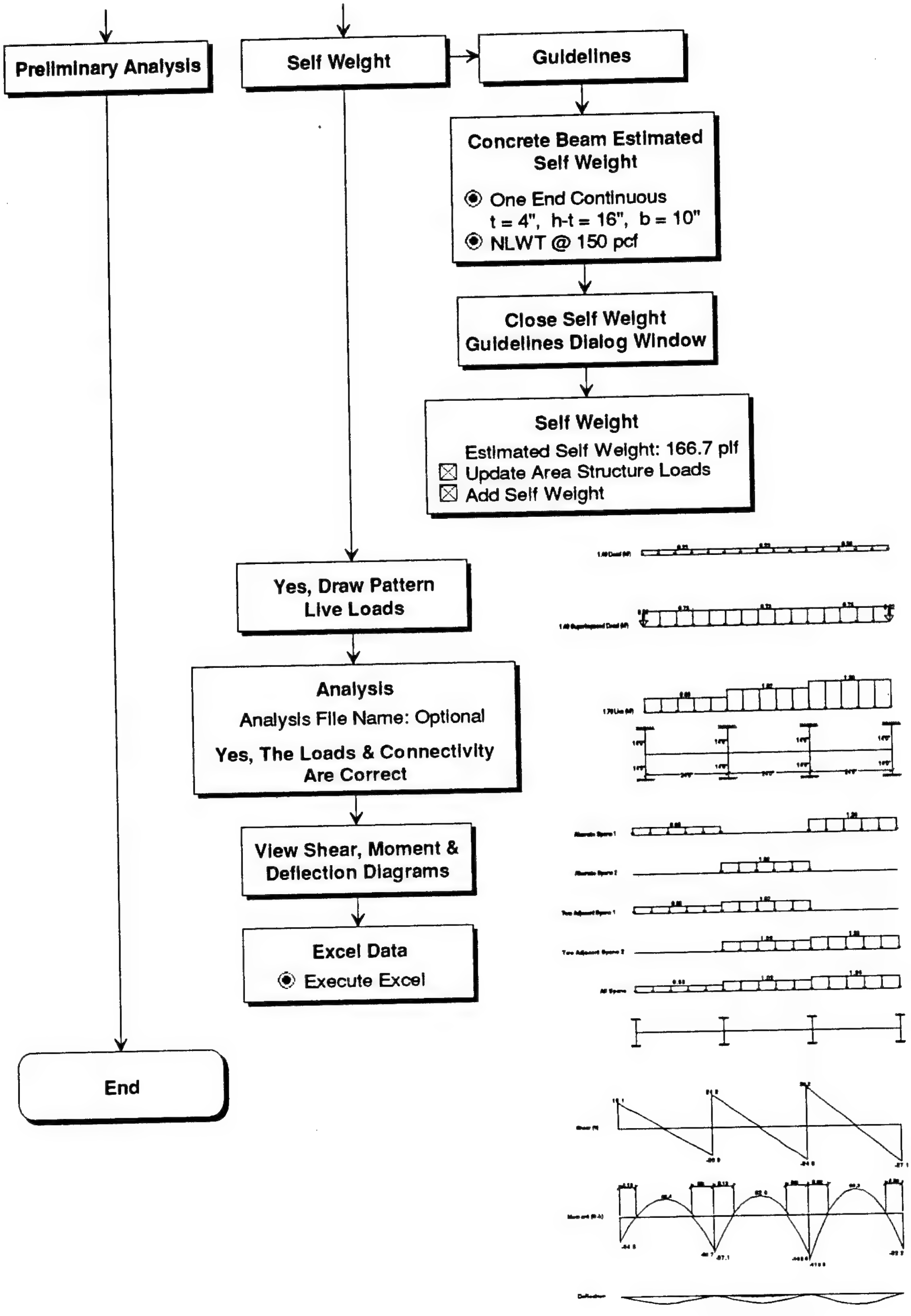
1. Bar joist selections based on 1993 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.
2. Approximate moment of inertia of the joist in inches^4 is:
   Ij = 26.767 (WLL) (L^3) (10^-6), where WLL = Live Load value in table;
   where L = Span - 0.33 in feet
3. Ponding check based on SJI Technical Digest. Refer to AISC Commentary section K2 for charts for Stress Constant U and Flexibility Constant C for joists bearing on beams.
   a. For joists bearing on steel beams, Cs must be greater than Csreq. This is not an automatic selection. Beam size and/or joist size may need to be increased.
   b. For joists bearing on walls, the ponding load includes dead load plus percentage of live load, plus computed ponding load. Selection is based on greatest load.

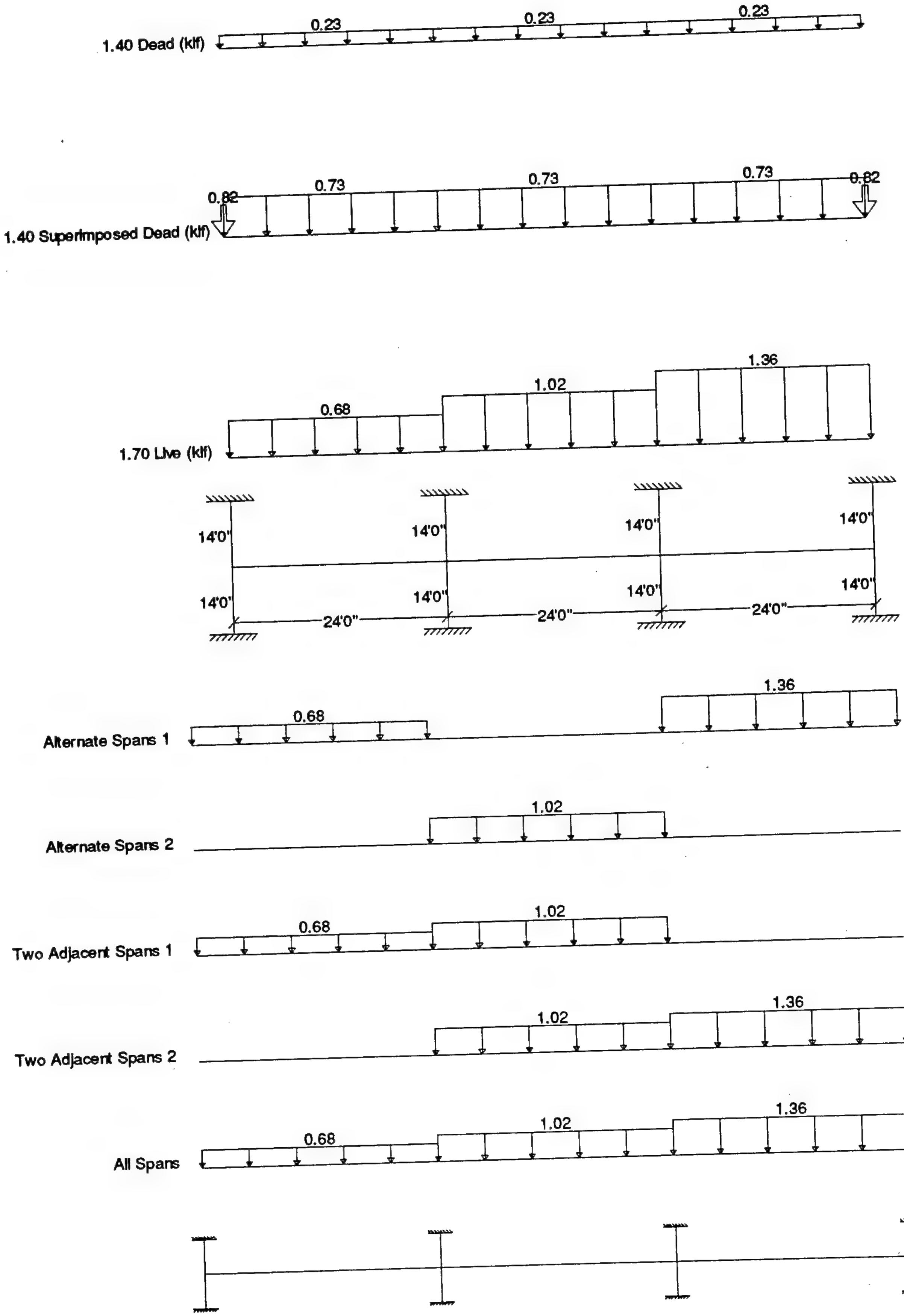
Widely Spaced Element Analysis: Continuous Beam



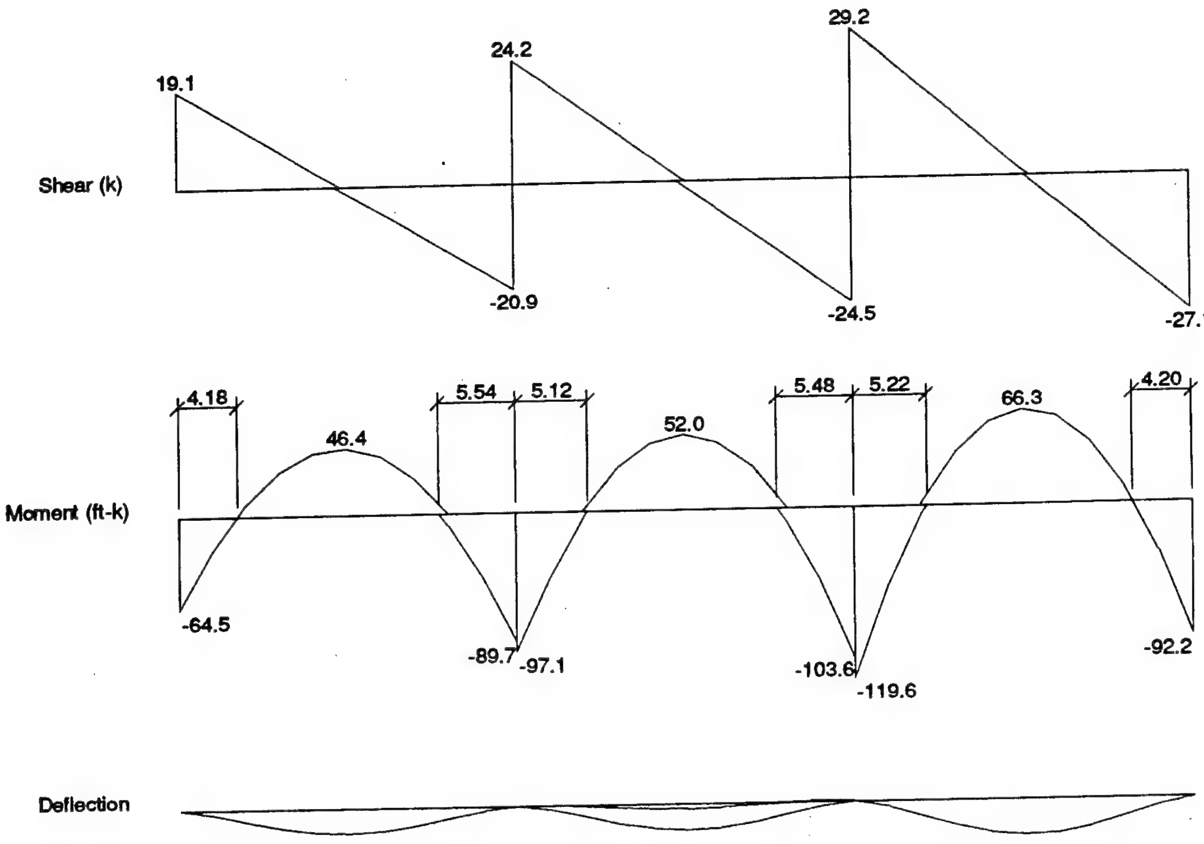



Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Kips
Load Combination: 1.4D+1.7L
☐ Use Actual Properties
☐ DL=Deck+Self Weight
☒ Pattern Occupancy Live Load
Connectivity
Connectivity
Left: Continuous Column
Right: Continuous Column
Adjacent Spans:
Left: 2
Right: 0
Column Connectivity
Above: Fixed
Height: 14'
Below: Fixed
Height: 14'
Column Connectivity
Above: Fixed
Height: 14'
Below: Fixed
Height: 14'
Connectivity
Continuous Column
Column Connectivity
Above: Fixed
Height: 14'
Below: Fixed
Height: 14'
Connectivity
Continuous Column


Preliminary Analysis
Self Weight
Guidelines
Concrete Beam Estimated Self Weight
One End Continuous
t = 4", h-t = 16", b = 10"
NLWT @ 150 pcf
Close Self Weight Guidelines Dialog Window
Self Weight
Estimated Self Weight: 166.7 plf
Update Area Structure Loads
Add Self Weight
Yes, Draw Pattern Live Loads
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

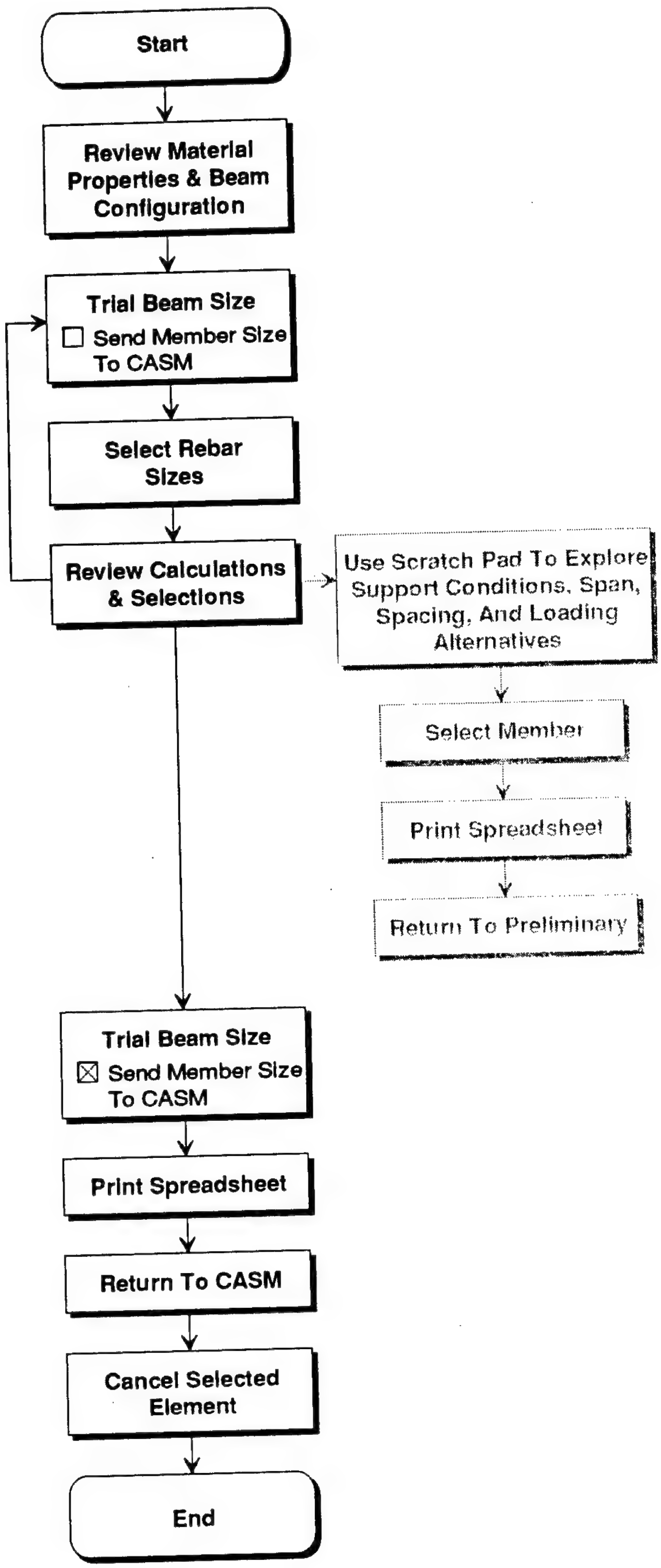


1.40 Dead (klf)
0.23
0.23
0.23
1.40 Superimposed Dead (klf)
0.82
0.73
0.73
0.73
0.82
1.70 Live (klf)
0.68
1.02
1.36
14'0"
14'0"
14'0"
14'0"
14'0"
14'0"
14'0"
14'0"
24'0"
24'0"
24'0"
Alternate Spans 1
0.68
1.36
Alternate Spans 2
1.02
Two Adjacent Spans 1
0.68
1.02
Two Adjacent Spans 2
1.02
1.36
All Spans
0.68
1.02
1.36



Total Combined Load: 1.4D + 1.7L -- Envelope

Concrete Beam Design



CONCRETE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme C	**Date: Sep 01, 1994**
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis

Load Combination: 1.4D + 1.7L

Member ID:

Connectivity: Column (Left)

Column (Right)

Beam Span:	24.0	ft
Trib Width=	8.0	ft
Depth Limit=	36.0	in. max
Concrete F'c=	4.0	ksi
Concrete Wt=	145	pcf
Steel Fy=	60.0	ksi

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead	12.2	6.3	8.8	2.9	2.7
Sup Dead	38.1	19.7	27.4	9.2	8.3
Live	69.3	40.3	56.1	17.0	16.2
Lmin Roof					
Snow					
Wind					
Summary	119.6	66.3	92.2	29.2	27.1

CASM Preliminary Beam Dimensions/Values:

ACI Preliminary Dimensions:		T-Beam Data:		Rebar Ratios:	
ACI Depth: L/ 21.0 =	13.7 in	ACI Slab Depth L/24=	4.0 in	pmax=	2.14 %
Width: h/ 1.75=	8.0 in	Selected Slab Depth=	**4.0 in**	1/2pmax=	1.07 %
Beam Configuration:		Effective Width bE=	72.0 in	pmin=	0.33 %
	Rectangular	Stress Blk Depth a(T)=	0.3 in		

Design Data: Bending phi(¢)= 0.90 beta(ß)= 0.85 m= 17.6 Ru= 581 psi

CASM Preliminary Beam Sizes and Reinforcing:

Beam Size b x h	Left end As	Left end ¢Mn	Midspan As	Midspan ¢Mn	Right end As	Right end ¢Mn	Shear Rebars	Volume (c.y.)	Weight (klf)
12 x 14	2.82	120	1.41	66	2.05	92	#3@ 5	1.04	0.17
10 x 16	2.32	120	1.18	66	1.71	92	#3@ 6	0.99	0.16
11 x 18	1.90	120	1.00	66	1.43	92	#3@ 7	1.22	0.20
12 x 20	1.63	120	0.87	66	1.24	92	#3@ 8	1.48	0.24
13 x 22	1.43	120	0.78	66	1.09	92	#3@ 9	1.77	0.29

CASM Preliminary Beam Design:

Beam Configuration: Rectangular	Trial Depth h= **16.0 in**	Cover Top= **1.5 in**	d=	13.5 in
	Trial Width b= **10.0 in**	Cover Btm= **1.5 in**	d'=	2.5 in

Bending Reinforcement:	Left end Layers	Reqd	Design	Midspan Layers	Reqd	Design	Right end Layers	Reqd	Design
Mu (kf)		120	123		66	75		92	123
Ru (psi)		875	883		485	527		675	883
p (%)		1.61	1.74		0.89	0.96		1.24	1.74
As (sq in.)		2.17	2.37		1.20	1.32		1.68	2.37
Rebar Option:	1	3 - #8		1	4 - #5		1	4 - #6	
Select Rebar:	1	3 - #8		1	3 - #6		1	3 - #8	

Shear Reinforcement:	Left End	Right End	Design Values:
Vu:	29.2 kips	27.1 kips	phi(¢)= 0.85
Reqd ¢Vs:	14.7 kips	12.6 kips	¢Vc= 14.5 k
Size&Spacing:	#3 @ 6 in	#3 @ 6 in	½¢Vc= 7.3 k

Properties and Quantities for Concrete Beam/Girder:

Dimensions (b x h): **10 x 16**	Volume: 1.0 c.y.	Weight= 0.16 klf	Rebar Wt= .18 tons

Notes:

1. Concrete beam/girder volume and weight does not include slab volume and weight.
2. ACI 318-89 Strength Design used for sizing member.

Truss Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

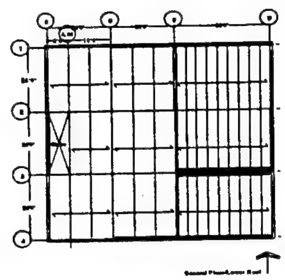
Material Steel

Select Element To Analyze & Design

Linear Truss-Custom

Select A Truss

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

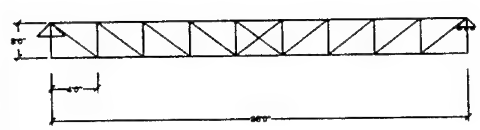
Analysis
Units: Feet & Pounds

Connectivity
Left: Hinge
Right: Roller

Truss - Custom

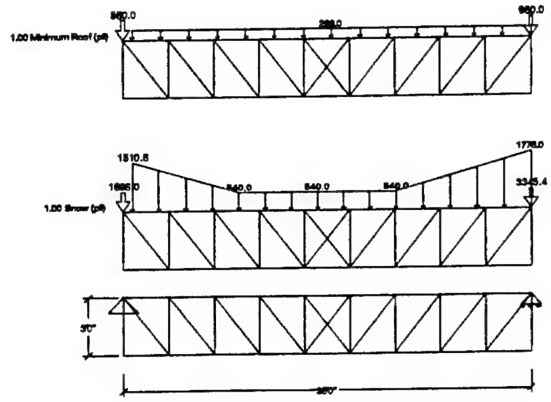
Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'

☐ Verticals
☐ Start At Bottom
☒ Left Support At Top
☒ Right Support At Top



Compare Min. Roof LL & Snow Loads

- **Snow Load Options**
  - ◉ Combined Snow Loads
- **Minimum Roof (LL)**
- **Compare Min. Roof LL & Snow Loads**
- **View Shear, Moment & Deflection Diagrams**



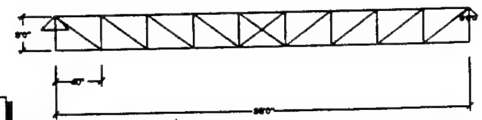
Load Combination D + S

- **Use Load Combination**
- **Set Factors**
  - Dead: 1.0
  - Snow: 1.0
- **Add**
- **OK Button To Close Dialog Window**
- **Highlight D+S In List**

Preliminary Analysis

- **Use Preliminary**
- **Analysis**
  - Units: Feet & Pounds
  - Load Combination: D+S
  - ☐ Use Actual Properties
  - ☐ DL=Deck+Self Weight
- **Connectivity**
  - Left: Hinge
  - Right: Roller

Preliminary Analysis



Truss - Custom

Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'

☐ Verticals
☐ Start At Bottom
☒ Left Support At Top
☒ Right Support At Top

Try Other Configurations

Snow Load Options

◉ Combined Snow Loads

Self Weight

Guidelines

Find Estimate For 36' Span & Flat Pitch

Close Self Weight Guidlines Dialog Window

Self Weight

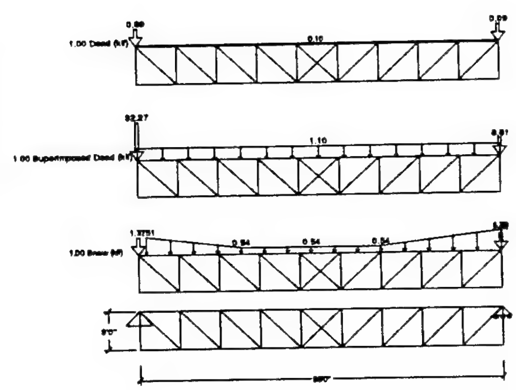
Estimated Self Weight: 96 plf
☐ Update Area Structure Loads
☒ Add Self Weight

4 plf x 24' o.c.

Analysis

Analysis File Name: Optional

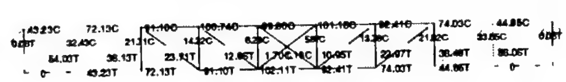
Yes, The Loads & Connectivity Are Correct



View Axial, Reactions & Deflection Diagrams

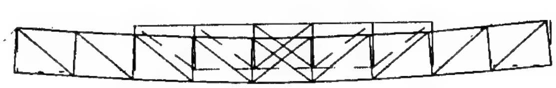
Excel Data

◉ Execute Excel

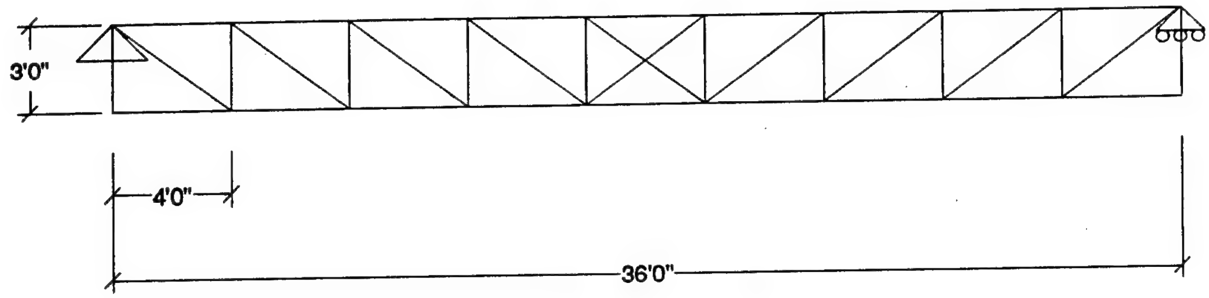


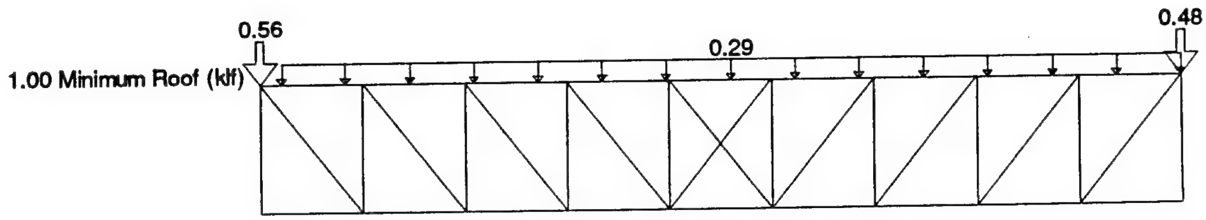
Total Combined Load: D + S – Axial (k)

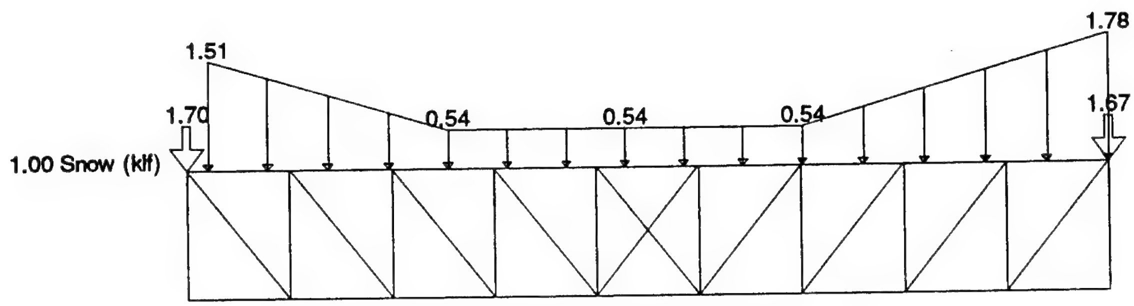
End

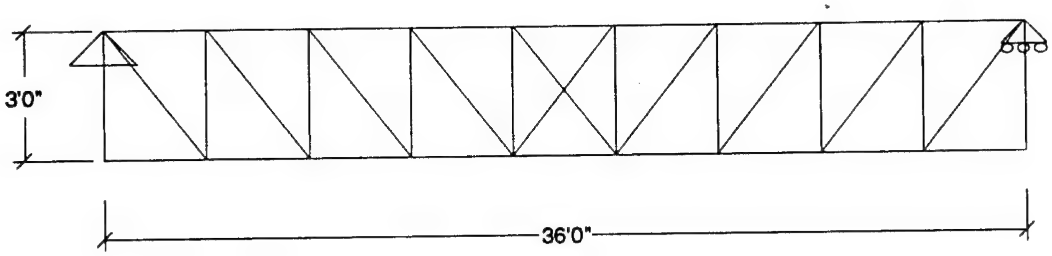


Total Combined Load: D + S – Deflection


3'0"
4'0"
36'0"


0.56
0.29
0.48
1.00 Minimum Roof (klf)


1.51
1.70
0.54
0.54
0.54
1.78
1.67
1.00 Snow (klf)


3'0"
36'0"

```
Project     : Office Building - Scheme C
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Thu Sep 01, 1994  2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 144.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```

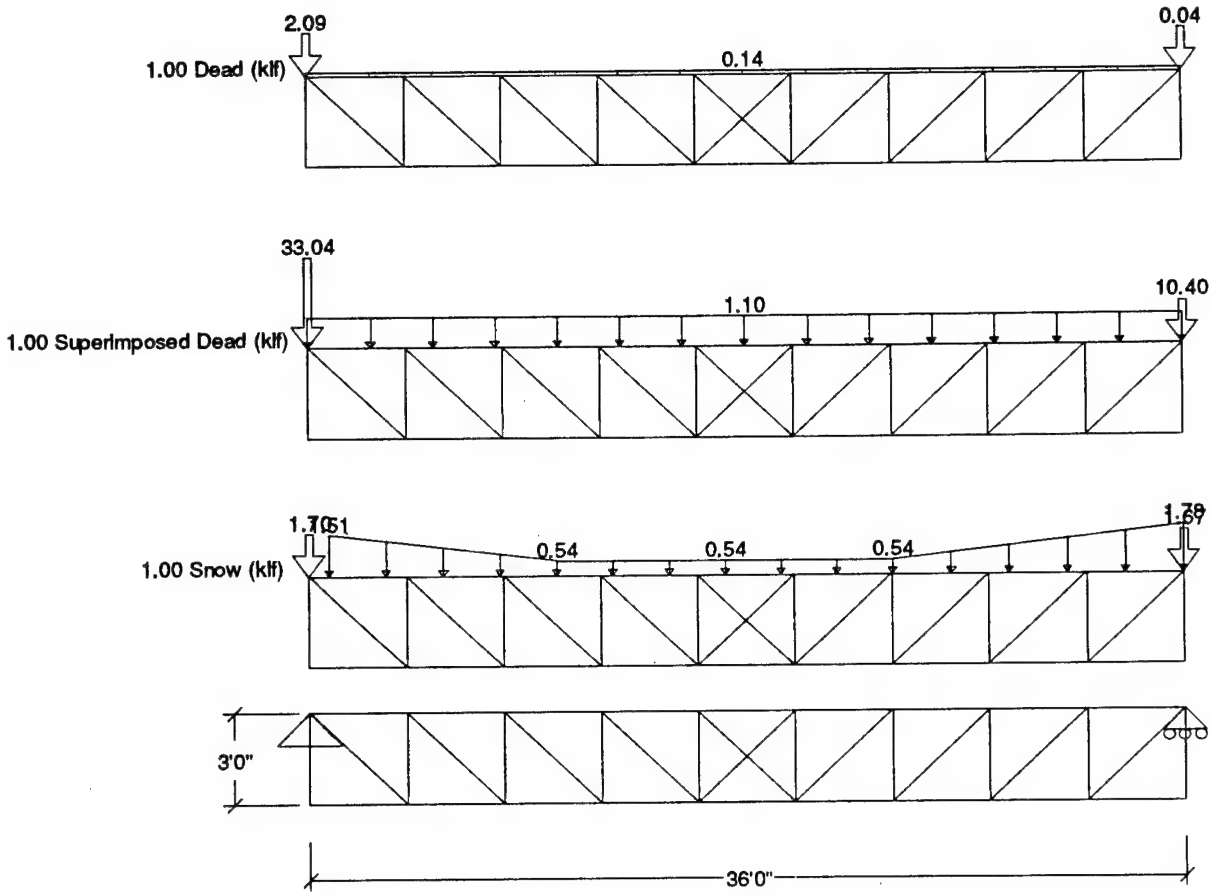
```
Project     : Office Building - Scheme C
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Thu Sep 01, 1994  2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 48.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```

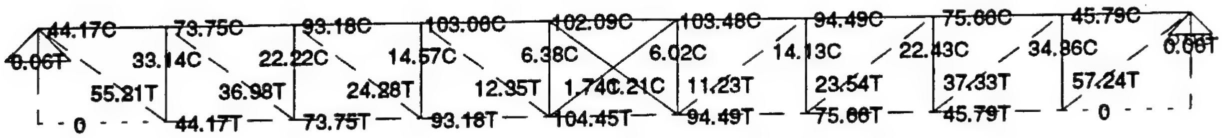
```
Project     : Office Building - Scheme C
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Thu Sep 01, 1994  2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 1032.0 sqft
Roof Slope     (F)  : 0.00 in 12
```

```
Lr = 20*R1*R2 >= 12
At >= 600         R1 = 0.60
F <= 4            R2 = 1.00
Lr = 12.00 psf
Minimum Lr = 12.0 psf
+----------------------+
|     Lr = 12.00 psf   |
+----------------------+
```

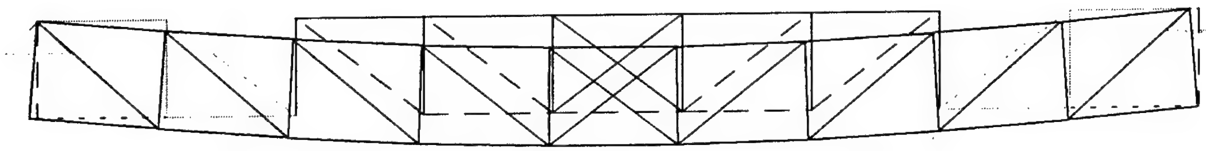
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

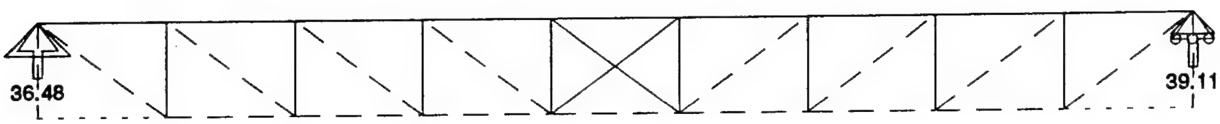




Total Combined Load: D + S -- Axial (k)

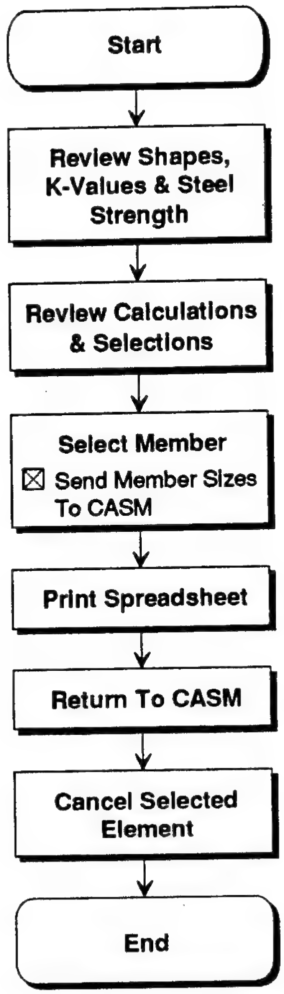


Total Combined Load: D + S -- Deflection



Total Combined Load: D + S -- Reactions (k)

Steel Truss Design



STEEL TRUSS PRELIMINARY DESIGN

Project: Office Building - Scheme C	**Date: Sep 01, 1994**
Location: Radford AAP	**Engr:**

Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left), Roller (Right)
Truss Span: 12.25 ft
Spacing: 24.00 ft

Fy= 36.0 ksi
Ft= 21.6 ksi
E= 29,000 ksi
Cc= 126.1

Load Combination: D + S

Load Type	Top Chord	Bottom Chord	Tens. Web	Comp. Web
Dead	7.5	-7.6	-3.8	2.3
Sup Dead	59.0	-59.8	-30.0	18.0
Live				
Lmin Roof				
Snow	37.0	-37.1	-23.4	14.1
Wind				
Summary	103.5	-104.5	-57.2	34.4
Length	4.00	4.00	5.00	3.00

Truss Member Design Table:

Member Size		As (in^2)	rx (in)	ry (in)	Kl/r	Fa (psi)	fa (psi)	Mbr Wt(plf)
Top Chord	**K=1.0**						**Shape Selection:**	**WT**
WT 8 x 18		5.28	2.41	1.52	31.58	19.8	19.6	18.0
WT 7 x 19		5.58	2.04	1.55	30.97	19.9	18.5	19.0
WT 5 x 19.5		5.73	1.24	1.98	38.71	19.3	18.1	19.5
Bottom Chord	**K=1.0**						**Shape Selection:**	**WT**
WT 5 x 16.5		4.85	1.26	1.94	38.10	21.6	21.5	16.5
WT 7 x 17		5.00	2.04	1.53	31.37	21.6	20.9	17.0
WT 4 x 17.5		5.14	0.97	2.03	49.64	21.6	20.3	17.5
Tension Web	**K=1.0**						**Shape Selection:**	**2L**
2L 2 x 2 x 3/8		2.72	0.59	0.87	101.01	21.6	21.0	9.4
2L 3.5 x 2.5 x 1/4		2.88	1.12	0.96	62.63	21.6	19.9	9.8
2L 3 x 3 x 1/4		2.88	0.93	1.26	64.52	21.6	19.9	9.8
Comp Web	**K=1.0**						**Shape Selection:**	**2L**
2L 3 x 2.5 x 3/16		1.99	0.95	0.99	37.74	19.4	17.3	6.8
2L 2.5 x 3 x 3/16		1.99	0.76	1.30	47.31	18.6	17.3	6.8
2L 2.5 x 2 x 1/4		2.13	0.78	0.80	45.92	18.7	16.1	7.2

CASM Steel Truss Member Selection:

Top Chord:	Kl/r=	31.6		As=	5.3	Tension Web Mbr:	Kl/r= 101.0			As= 2.7
WT 8 x 18	fa=	19.6	<	Fa=	19.8	2L 2 x 2 x 3/8	fa= 21.0	<	Fa= 21.6	
Bottom Chord:	Kl/r=	38.1		As=	4.9	Compression Web Mbr:	Kl/r= 37.7			As= 2.0
WT 5 x 16.5	fa=	21.5	<	Fa=	21.6	2L 3 x 2.5 x 3/16	fa= 17.3	<	Fa= 19.4	

Notes:

1. Steel member properties from ASD - AISC Steel Construction Manual, 9th edition

Column Load Run Down

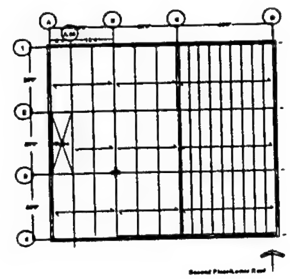
Start

Use Loads & Design Tool Palette

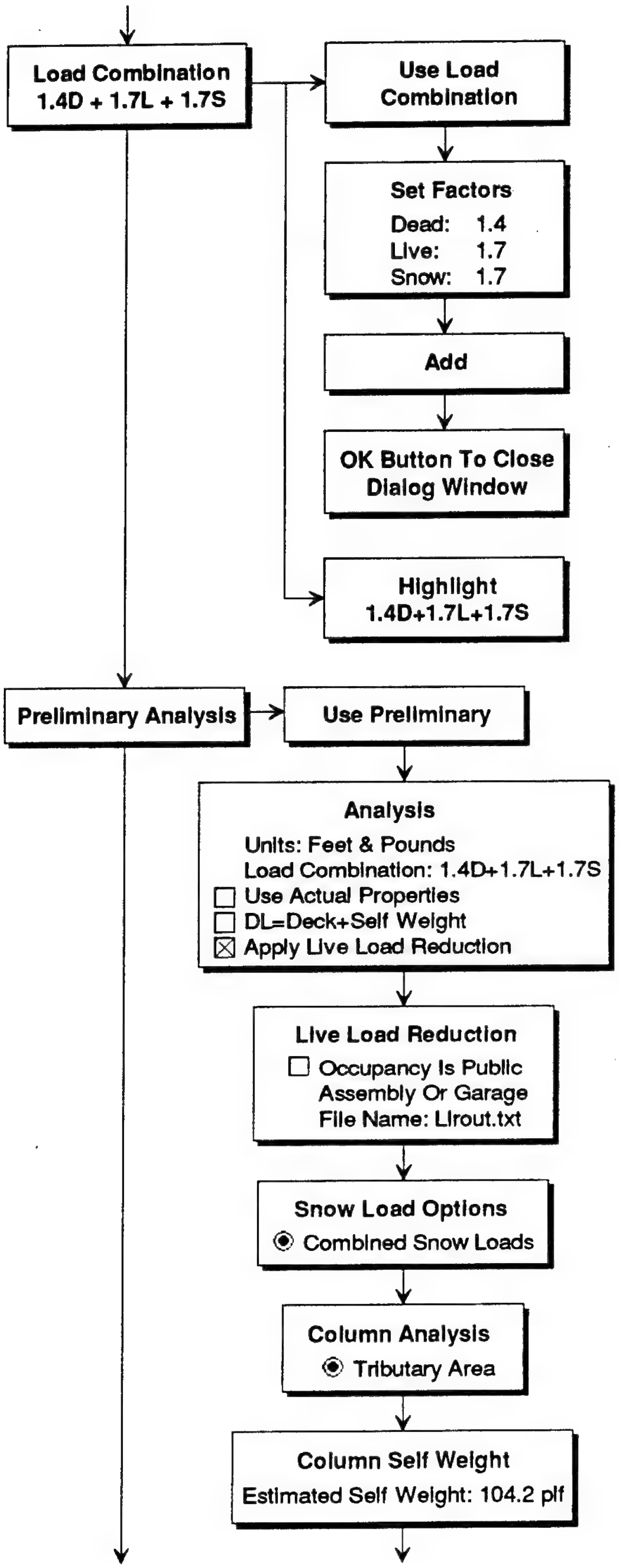
Material Concrete

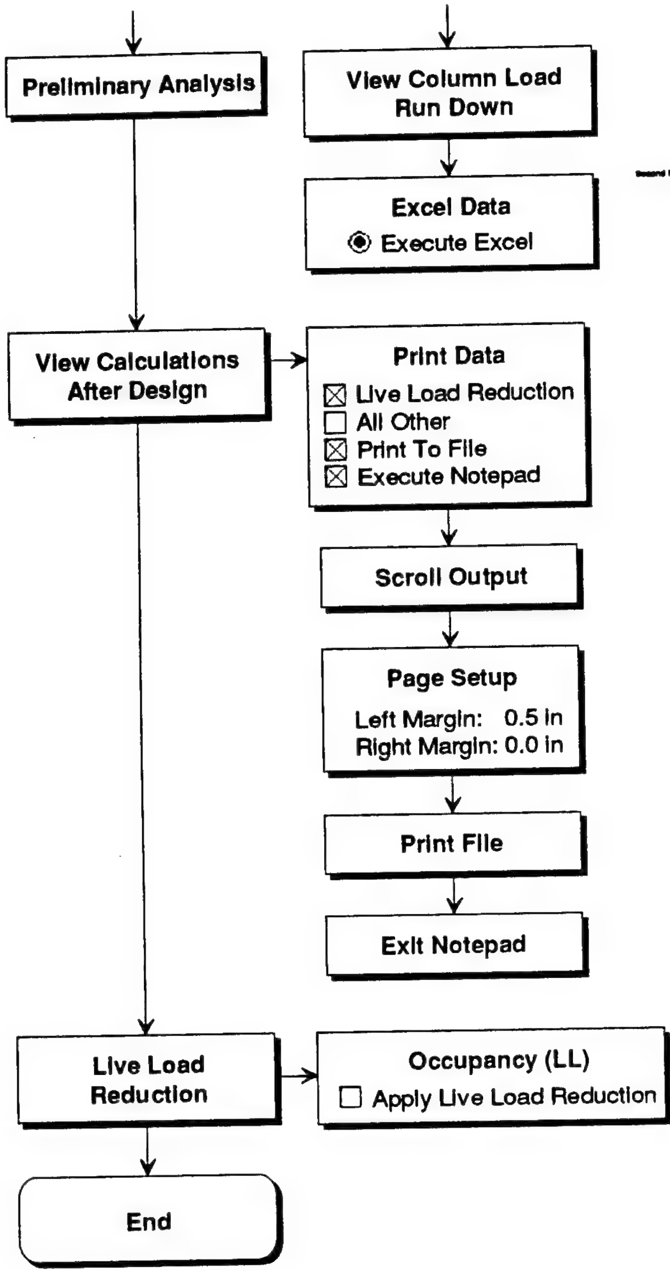
Live Load Reduction → Occupancy (LL) ☒ Apply Live Load Reduction

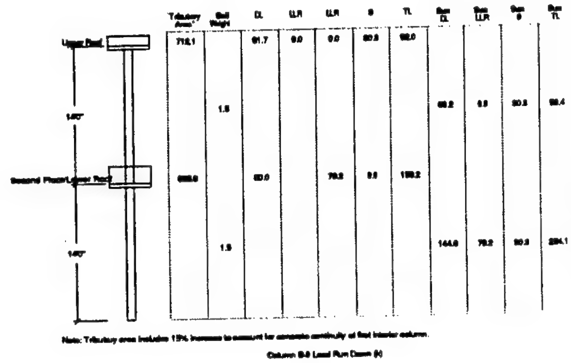
Select Element To Analyze & Design → Column Rolled Section → Select Column B3 → Review Element Attributes & Guidelines

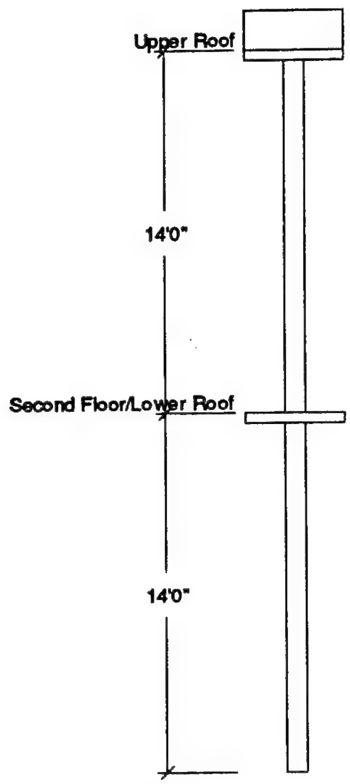


Compare Min. Roof LL & Snow Loads → Use Compare Min. Roof LL & Snow Loads → Analysis Units: Feet & Pounds → Snow Load Options ◉ Combined Snow Loads → Minimum Roof (LL) → Column Analysis ◉ Tributary Area → Compare Min. Roof LL & Snow Loads


Load Combination
1.4D + 1.7L + 1.7S
Use Load Combination
Set Factors
Dead: 1.4
Live: 1.7
Snow: 1.7
Add
OK Button To Close Dialog Window
Highlight
1.4D+1.7L+1.7S
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: 1.4D+1.7L+1.7S
Use Actual Properties
DL=Deck+Self Weight
Apply Live Load Reduction
Live Load Reduction
Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Snow Load Options
Combined Snow Loads
Column Analysis
Tributary Area
Column Self Weight
Estimated Self Weight: 104.2 plf


Preliminary Analysis
View Column Load Run Down
Excel Data
Execute Excel
View Calculations After Design
Print Data
Live Load Reduction
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Live Load Reduction
Occupancy (LL)
Apply Live Load Reduction
End

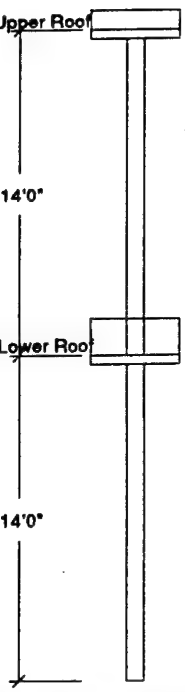




Level	Tributary Area*	Lr	S	Sum Lr	Sum S
Upper Roof	712.1	8.9	16.0		
				8.9	16.0
Second Floor/Lower Roof	665.6	0.0	0.0		
				8.9	16.0

Note: Tributary area includes 15% increase to account for concrete continuity at first interior column.
Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme C
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Thu Sep 01, 1994   3:02 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 576.0 sqft
Roof Slope      (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
200 < At < 600  R1 = 1.2-0.001*At
                R1 = 0.624
F <= 4          R2 = 1.00
Lr = 12.48 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 12.48 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



	Tributary Area*	Self Weight	DL	LLR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
Upper Roof	712.1		61.7	0.0	0.0	27.2	88.9				
14'0"		1.5						63.2	0.0	27.2	90.4
Second Floor/Lower Roof	665.6		80.0		79.2	0.0	159.2				
14'0"		1.5						144.6	79.2	27.2	251.1

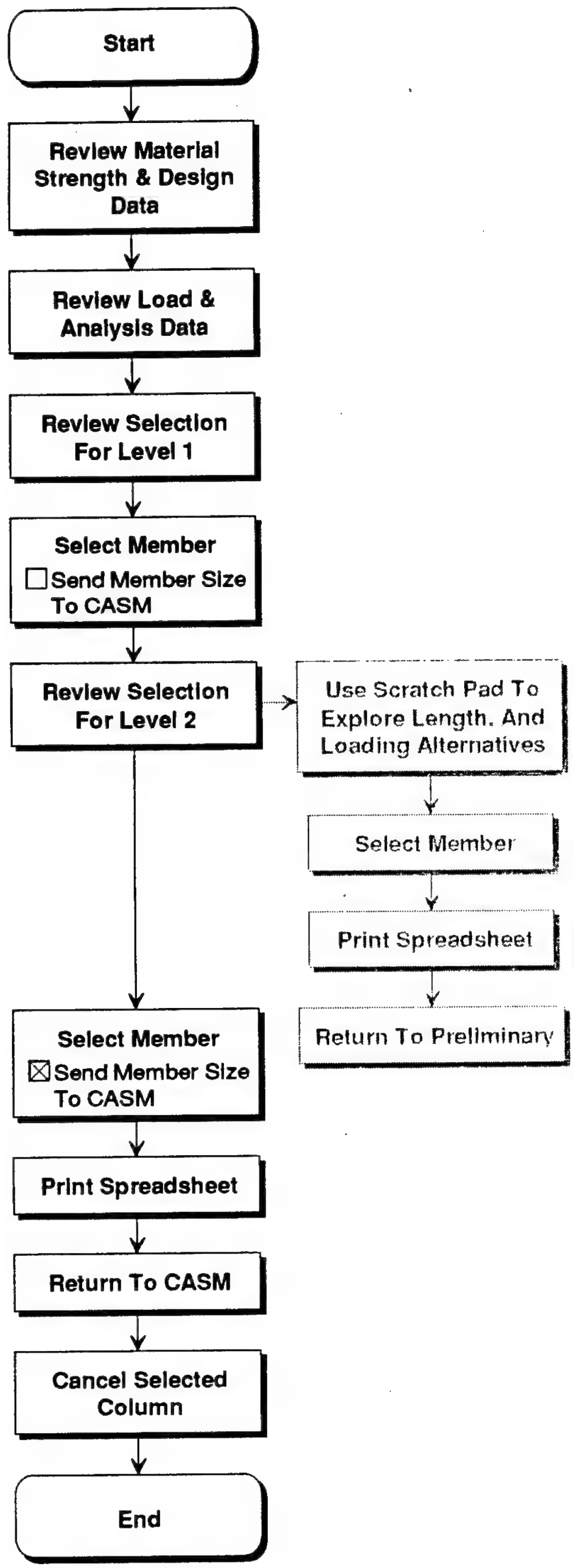
Note: Tributary area includes 15% increase to account for concrete continuity at first interior column.

Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme C
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Thu Sep 01, 1994  3:08 PM

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Office: Offices (Lo) :   50.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+-------------------------+
|      L = 28.13 psf      |
+-------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Corridor: Main (Lo) :  100.0 psf
Tributary area (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
```

```
L = 56.3 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 50.0 psf
+------------------------+
|     L = 56.25 psf      |
+------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Files & Storage (Lo) :  150.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo > 100.0 psf
Member supports only one floor.
No live load reduction taken.
L = Lo
+------------------------+
|     L = 150.00 psf     |
+------------------------+
```

Concrete Column Design



CONCRETE COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme C	Date: Sep 01, 1994
Location: Radford AAP	Engr:

CASM Load & Analysis Data:

Method: Analysis Load Combination: 1.4D + 1.7L + CConc F'c= 4.0 ksi
Member ID: B-3 Size Limit= 16.0 in. max Fy= 60.0 ksi

Name	Level	Flr to Flr Ht	Trib Area	Floor Level Area Load (kips) Dead	Live	Lmin	Snow	Wind	Load Totals
	6								
	5								
	4								
	3								
Upper Roof	2	14.00	576	63.2			27.2		90.4
Second Floor/Lo	1	14.00	576	144.6	79.2		27.2		251.1

CASM Column Selection Table

Column Data:

- Floor Level: 2
- Column Shape: Square
- Reinf. Ratio: 1.5 %
- Ties: Tied
- Fire Rating: 1 Hour(s)
- Estimated Ave. Beam Depth: 20.0 in.
- Concrete Wgt: 145 pcf

Floor Level	Calculated Values: Ag (in^2)	b (in)	p (%)	Ast (in^2)	Rebar & Size	Pu (k)
6						
5						
4						
3						
2	111.8	11	1.0	1.12	4- #5	270
1	219.0	15	1.0	2.19	4- #7	504

CASM Column Design Data:

Level	b (in)	Ag (in^2)	Rebar & Size	Ast (in^2)	p (%)	Pu (kip)	Reqd Pu	Pc (kip)	Tie & Spacing
- 6									
- 5									
- 4									
- 3									
Upper Roof - 2	15	225	4- #5	1.24	0.6	468	90		#3@10
r/Lower Roof - 1	15	225	4- #7	2.40	1.1	504	251		#3@14

Notes:

1. Initial column size based on larger of:
   a. Size based on axial load Ag=Pn/(.8*(.85f'c+p*(fy-.85f'c)))
   b. Size based on fire resistance rating.
   c. Size assuming k=1.0 and neglecting effects of slenderness by solving for b:
      first story - - - - - - - lu/b <= 10
      above first story - lu/b <= 14
2. Slenderness is considered when selecting a column size less than the calculated value.

Lateral Resistance Philosophy

Steps Required

1. Create building volume

2. Define a structural grid

3. Layout structural framing on ALL levels

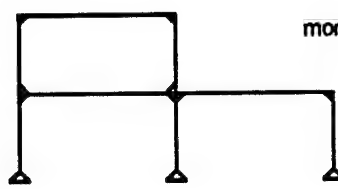
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads

5. Select a load combination including wind or seismic loads

6. Define N-S & E-W vertical resistance system

   Options:

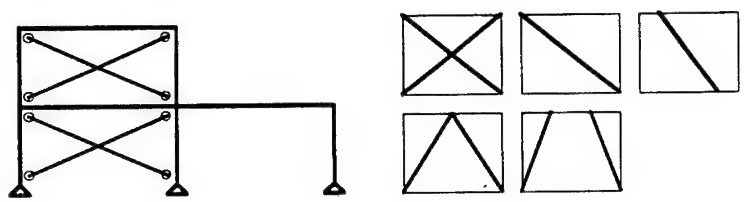
   1. Unbraced Frames



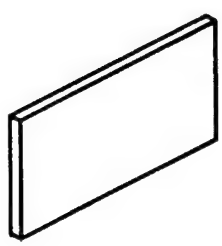
moment resistant connections
or
knee bracing

   2. Braced Frames

      A. Trussing



      B. Shear Walls

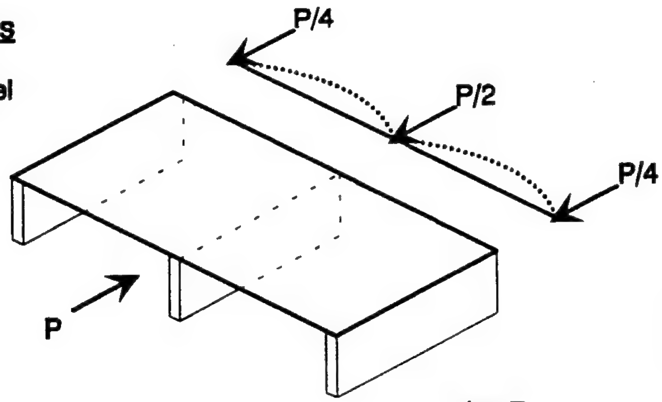


7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

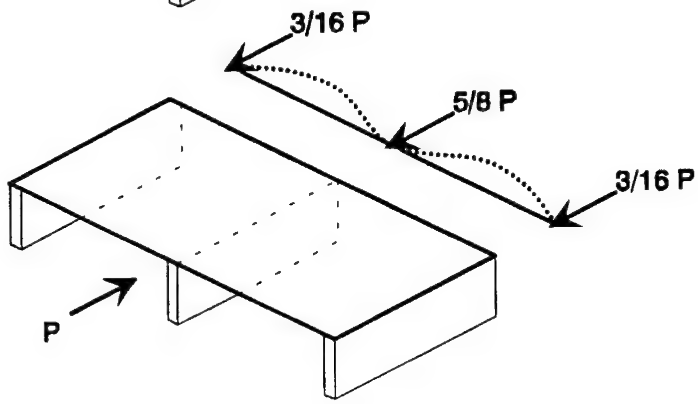
Flexible Diaphragms

Simple Beam Model
(tributary area)



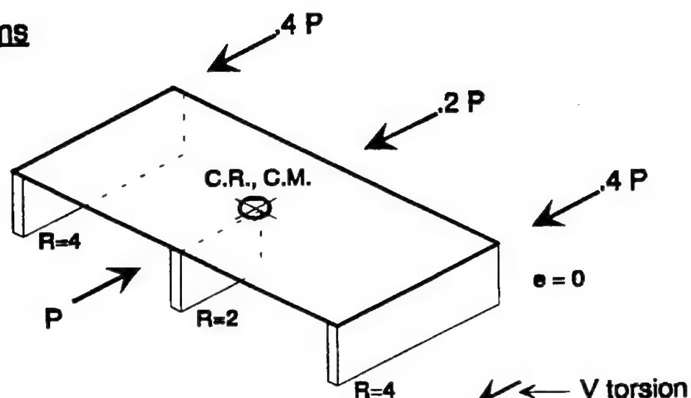
* No Torsion

Continuous Beam Model



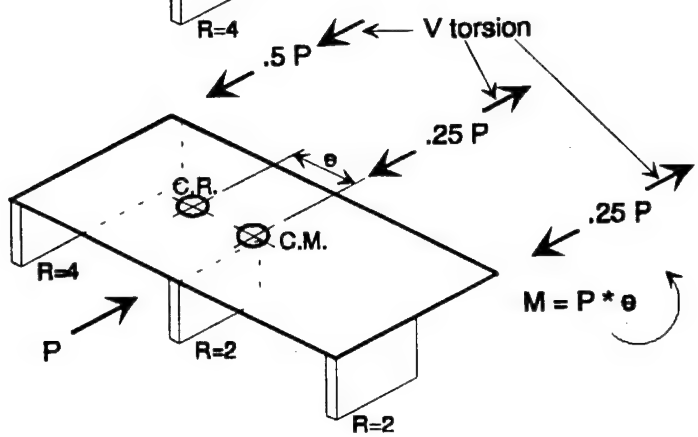
Rigid Diaphragms

Symmetrical

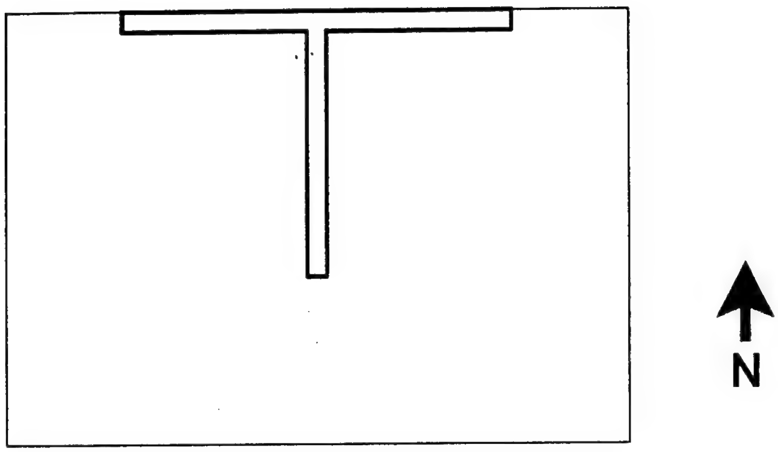


Torsion
(even accidental minimum required)

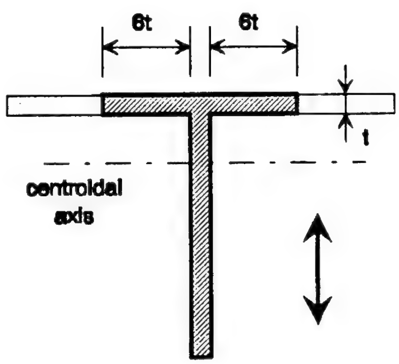
Non-Symmetrical



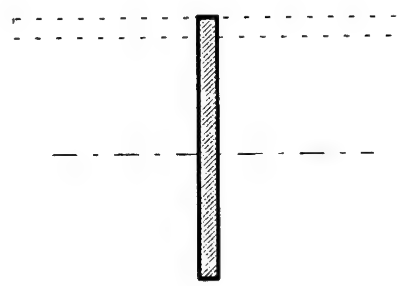
Monolithic Perpendicular Shear Walls



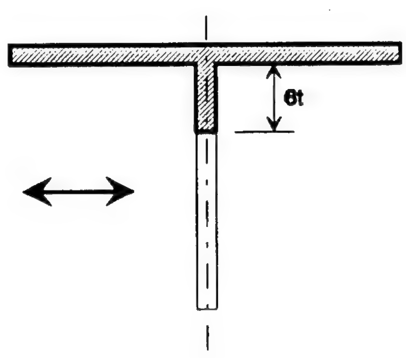
For N-S



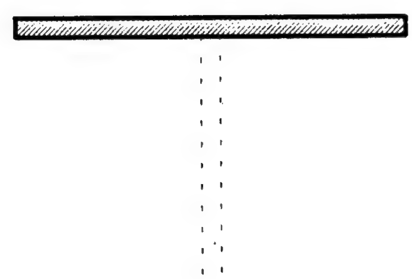
or



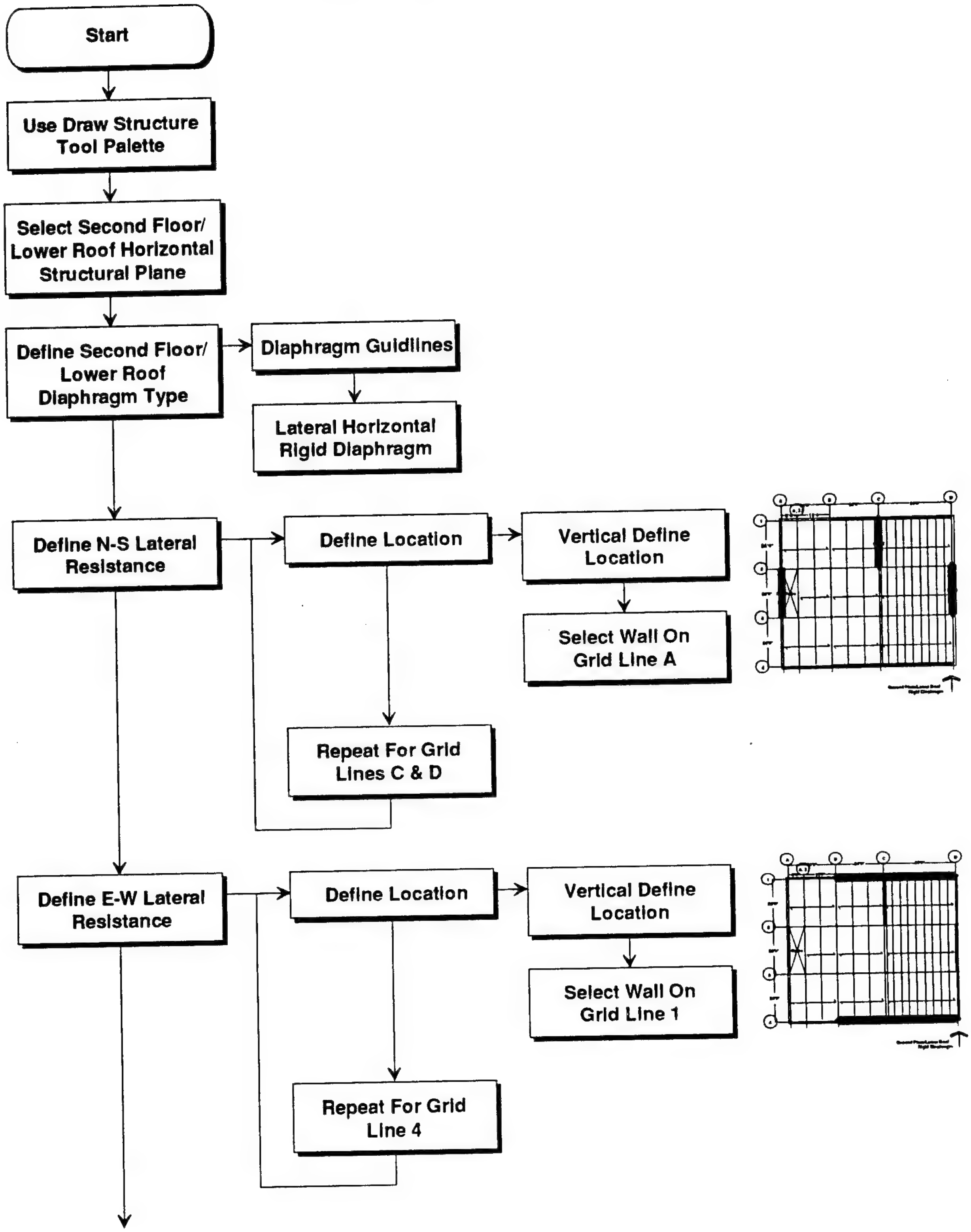
For E-W

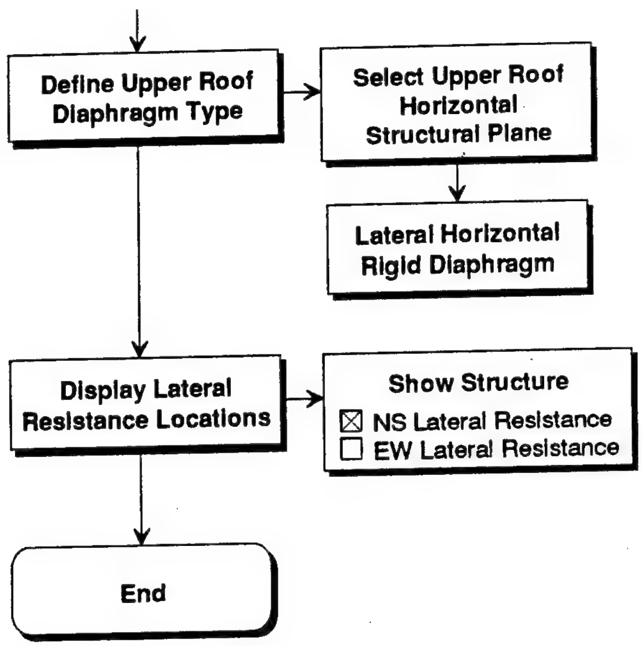


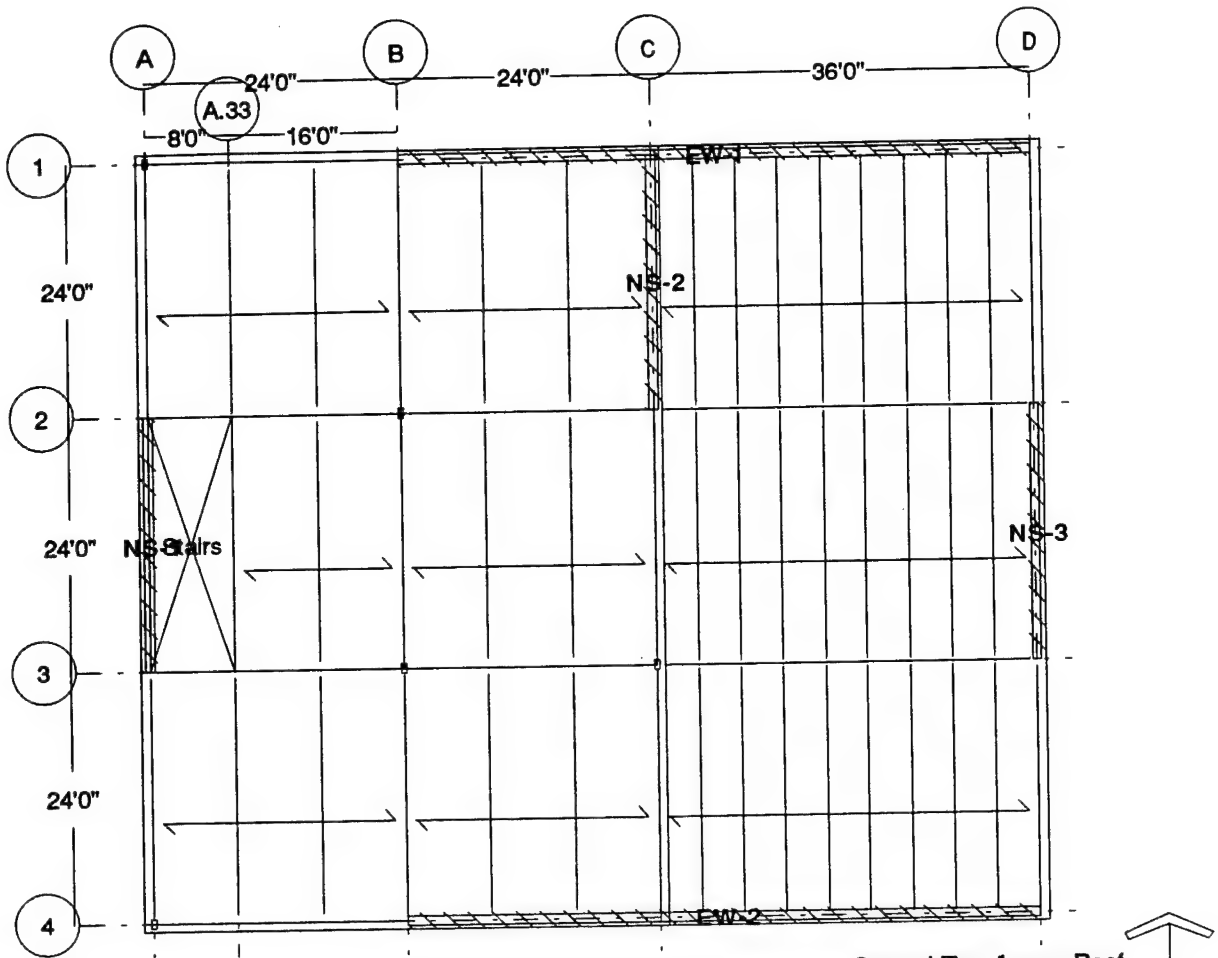
or



Define Lateral Resistance

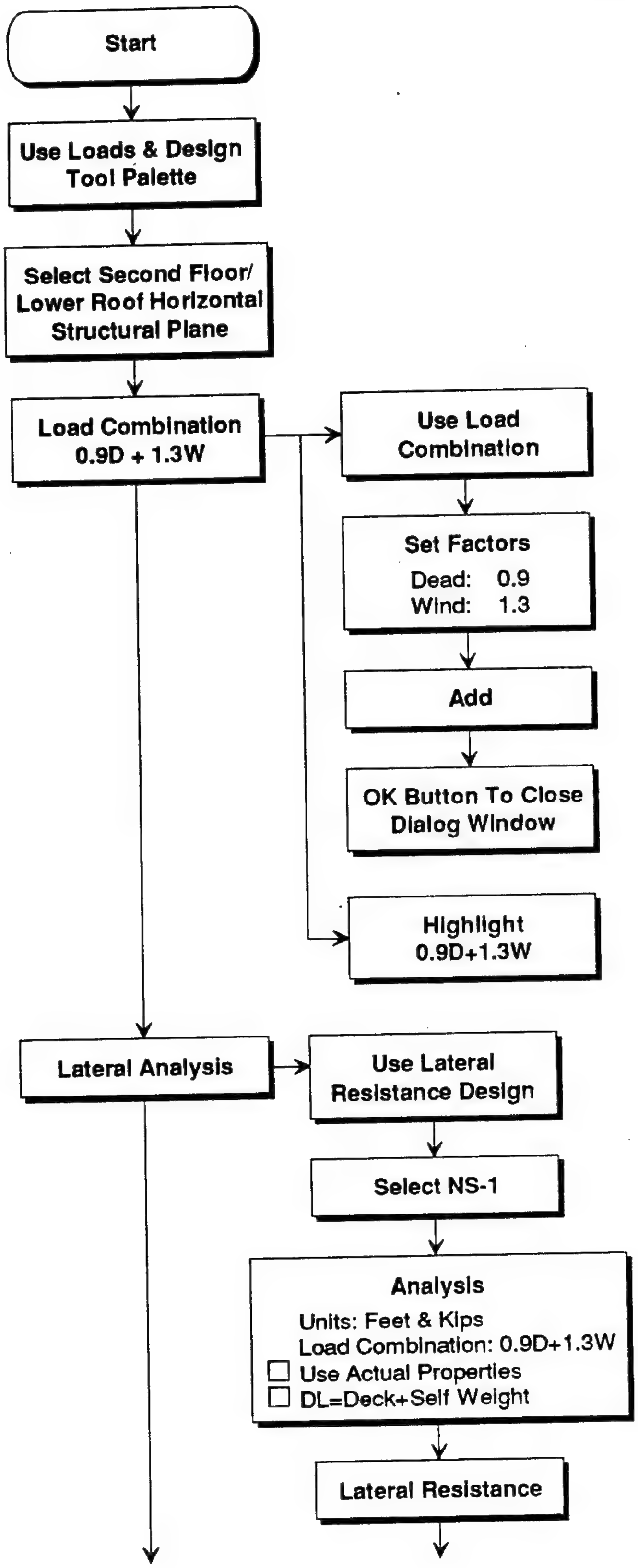



Define Upper Roof Diaphragm Type
Select Upper Roof Horizontal Structural Plane
Lateral Horizontal Rigid Diaphragm
Display Lateral Resistance Locations
Show Structure
☒ NS Lateral Resistance
☐ EW Lateral Resistance
End



Second Floor/Lower Roof
Rigid Diaphragm

Wind Lateral Analysis



Lateral Analysis

Wind Load Options

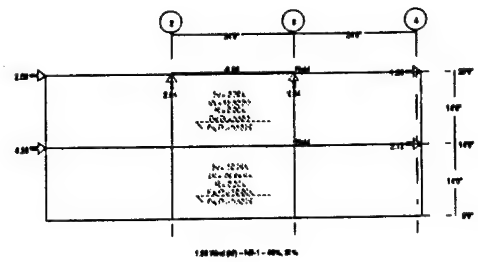
Wind Direction: South
When 2 Wind Loads: Max. Suction
Wind Load: GCpi = 0

Rigid Horizontal Diaphragm Calculations

File Name: Rigidout.txt
☐ Enter Deflections At Each Level
☒ Consider Perpendicular Wall...
☐ ... Use Method C ...

View Loads

Select Cancel



View Output

Print Data

☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad

Scroll Output

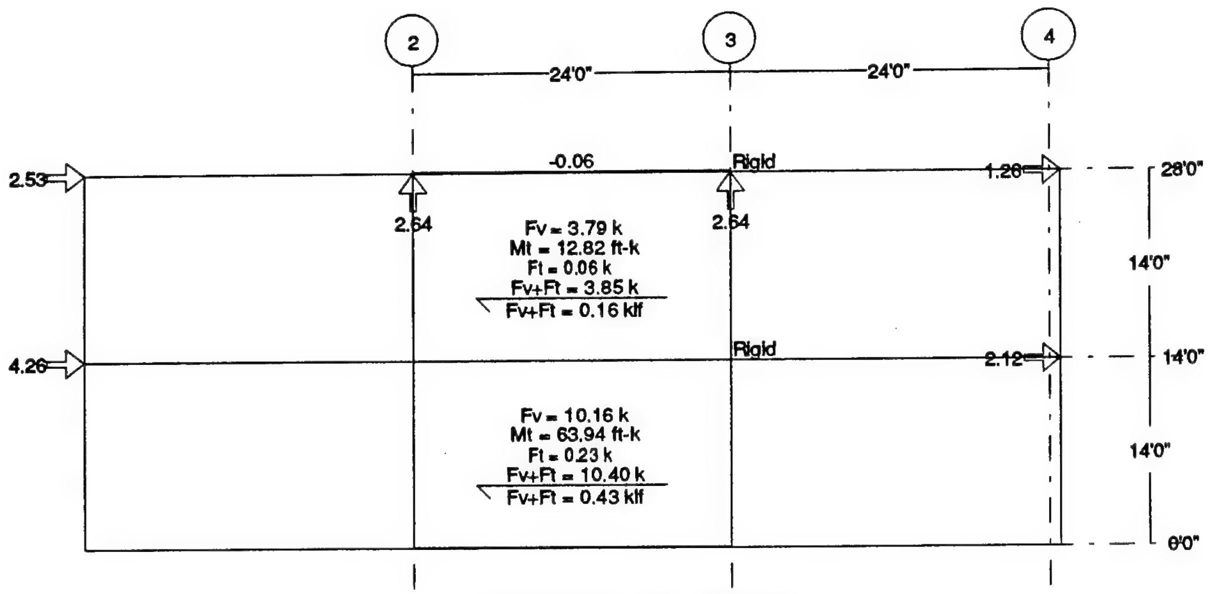
Page Setup

Left Margin: 0.5 in
Right Margin: 0.0 in

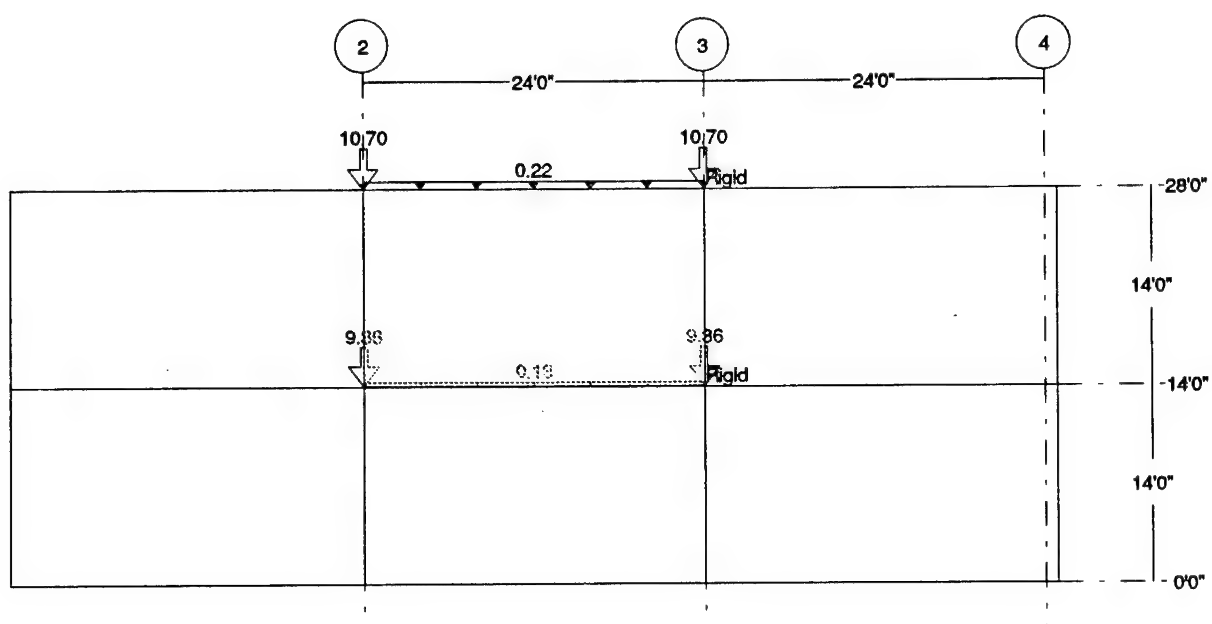
Print File

Exit Notepad

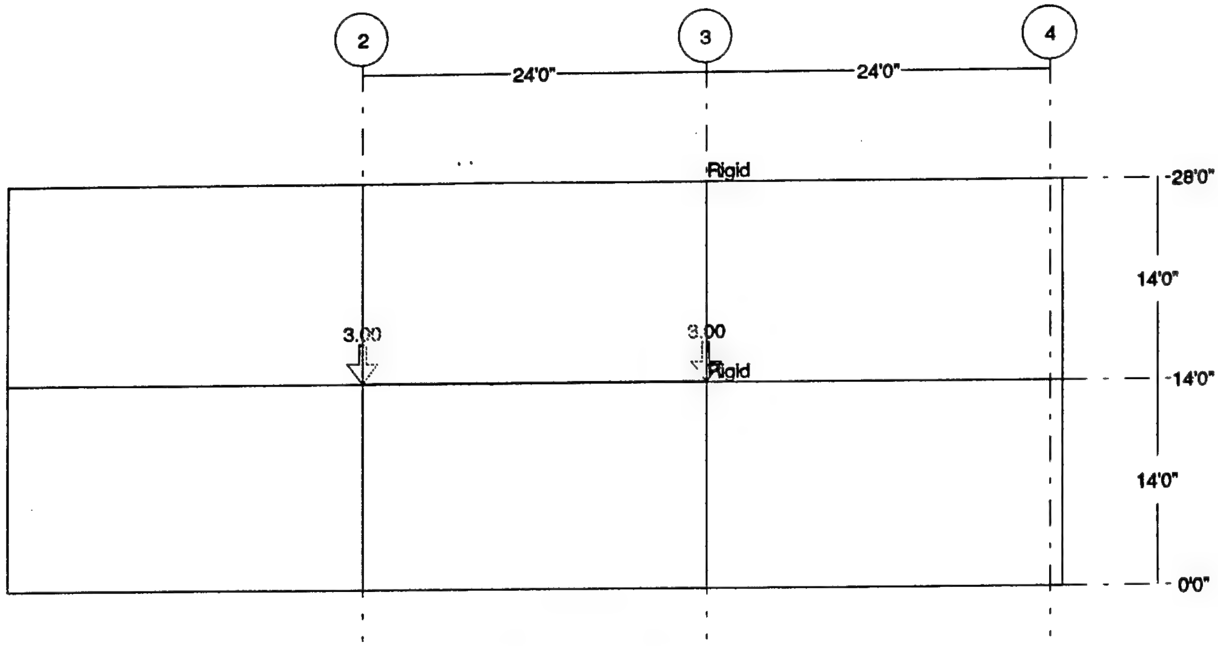
End



1.30 Wind (klf) -- NS-1 -- 46%, 31%



0.90 Superimposed Dead (klf) -- NS-1



0.90 Dead (klf) -- NS-1

```
Project     : Office Building - Scheme C
Location    : Radford AAP
Time        : Thu Sep 01, 1994  3:39 PM
```

***************** Rigid Horizontal Diaphragm Calculations *****************

NS-1

Level Height: 14.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
NS-1	0.83	24.00	20.0	12.00	240	0.00	0
Sum			20.0		240		0

Centroid = sum(MomentArea)/sum(Area)
NS Centroid : 12.00 ft   EW Centroid : 0.00 ft
Av : 20.00 sqft

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
NS-1	0.83	24.00	960	20.0	0.00	0	960
Sum							960

Deflection : 0.085 in   Height : 14.0 ft

Level Height: 28.0 ft

Same As NS-1: Height 14.0 ft

NS Centroid	:	12.00 ft	EW Centroid	:	0.00 ft
Av	:	20.00 sqft	Moment of Inertia	:	960 ft^4
Deflection	:	0.085 in	Height	:	14.0 ft

NS-2

Level Height: 14.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
NS-2	0.83	24.42	20.3	12.21	248	0.00	0
EW-1	0.83	5.00	4.2	24.00	100	-2.92	-12
EW-1	0.83	5.00	4.2	24.00	100	2.92	12
Sum			28.7		448		0

Centroid = sum(MomentArea)/sum(Area)

NS Centroid	:	15.63 ft	EW Centroid	:	0.00 ft
Av	:	20.35 sqft			

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/ 12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
NS-2	0.83	24.42	1011	20.3	-3.43	239	1250
EW-1	5.00	0.83	0	4.2	8.37	292	292
EW-1	5.00	0.83	0	4.2	8.37	292	292
Sum							1833

Deflection	:	0.071 in	Height	:	14.0 ft

Level Height: 28.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
NS-2	0.83	24.42	20.3	12.21	248	0.00	0
EW-1	0.83	5.00	4.2	24.00	100	-2.92	-12
Sum			24.5		348		-12

Centroid = sum(MomentArea)/sum(Area)

NS Centroid	:	14.21 ft	EW Centroid	:	-0.50 ft
Av	:	20.35 sqft			

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/ 12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
NS-2	0.83	24.42	1011	20.3	-2.00	82	1093
EW-1	5.00	0.83	0	4.2	9.79	399	399
Sum							1492

Deflection : 0.074 in Height : 14.0 ft

NS-3

Level Height: 14.0 ft

Same As NS-1: Height 14.0 ft

NS Centroid : 12.00 ft EW Centroid : 0.00 ft
Av : 20.00 sqft Moment of Inertia: 960 ft^4
Deflection : 0.085 in Height : 14.0 ft

EW-1

Level Height: 14.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
EW-1	0.83	60.00	50.0	0.00	0	30.00	1500
NS-2	0.83	5.00	4.2	-2.92	-12	24.00	100
Sum			54.2		-12		1600

Centroid = sum(MomentArea)/sum(Area)
NS Centroid : -0.22 ft EW Centroid : 29.54 ft
Av : 50.00 sqft

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/ 12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
EW-1	0.83	60.00	15000	50.0	0.46	11	15011
NS-2	5.00	0.83	0	4.2	-5.54	128	128
Sum							15139

Deflection : 0.025 in Height : 14.0 ft

Level Height: 28.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
EW-1	0.83	24.42	20.3	0.00	0	12.21	248
NS-2	0.83	5.00	4.2	-2.92	-12	24.00	100
Sum			24.5		-12		348

Centroid = sum(MomentArea)/sum(Area)
NS Centroid : -0.50 ft EW Centroid : 14.21 ft
Av : 20.35 sqft

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
EW-1	0.83	24.42	1011	20.3	-2.00	82	1093
NS-2	5.00	0.83	0	4.2	9.79	399	399
Sum							1492

Deflection : 0.074 in Height : 14.0 ft

EW-2

Level Height: 14.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
EW-2	0.83	60.00	50.0	0.00	0	30.00	1500
Sum			50.0		0		1500

Centroid = sum(MomentArea)/sum(Area)
NS Centroid : 0.00 ft EW Centroid : 30.00 ft
Av : 50.00 sqft

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
EW-2	0.83	60.00	15000	50.0	0.00	0	15000
Sum							15000

Deflection : 0.025 in Height : 14.0 ft

Level Height: 28.0 ft

Centroidal Axis

Name	t (ft)	l (ft)	Area (sqft)	NS Arm (ft)	NS Moment Area (ft^3)	EW Arm (ft)	EW Moment Area (ft^3)
EW-2	0.83	24.00	20.0	0.00	0	12.00	240
Sum			20.0		0		240

Centroid = sum(MomentArea)/sum(Area)
NS Centroid : 0.00 ft EW Centroid : 12.00 ft
Av : 20.00 sqft

Moment of Inertia

Name	b (ft)	h (ft)	bh^3/12 (ft^4)	Area (sqft)	d (ft)	Ad^2 (ft^4)	I+Ad^2 (ft^4)
EW-2	0.83	24.00	960	20.0	0.00	0	960
Sum							960

Deflection : 0.085 in Height : 14.0 ft

Center of Rigidity

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/sum(R)	x (ft)	R*x
NS-1	14.0	960	20	0.085	11.793	31.34%	0.8	9.827
NS-2	14.0	1833	20	0.071	14.046	37.33%	48.8	685.899
NS-3	14.0	960	20	0.085	11.793	31.34%	84.8	1000.400
Sum					37.631			1696.127

Centroid from lower left = sum(R*x)/sum(R) : 45.07 ft
Maximum rigid diaphragm dimension : 85.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 2.24 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/sum(R)	x (ft)	R*x
NS-1	28.0	960	20	0.170	5.896	46.19%	0.8	4.914
NS-2	28.0	1492	20	0.146	6.870	53.81%	48.3	332.073
Sum					12.766			336.986

Centroid from lower left = sum(R*x)/sum(R) : 26.40 ft
Maximum rigid diaphragm dimension : 49.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 1.56 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/sum(R)	x (ft)	R*x
EW-1	14.0	15139	50	0.025	39.981	50.02%	72.6	2903.007
EW-2	14.0	15000	50	0.025	39.957	49.98%	0.8	33.297
Sum					79.938			2936.304

Centroid from lower left = sum(R*x)/sum(R) : 36.73 ft
Maximum rigid diaphragm dimension : 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 0.10 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	28.0	1492	20	0.099	10.063	52.50%	72.3	727.898
EW-2	28.0	960	20	0.110	9.105	47.50%	0.8	7.588
Sum					19.168			735.486

```
Centroid from lower left = sum(R*x)/sum(R)       :   38.37 ft
Maximum rigid diaphragm dimension                :   73.67 ft
Eccentricity (e) = centroid-(max dimension)/2    :    1.54 ft
```

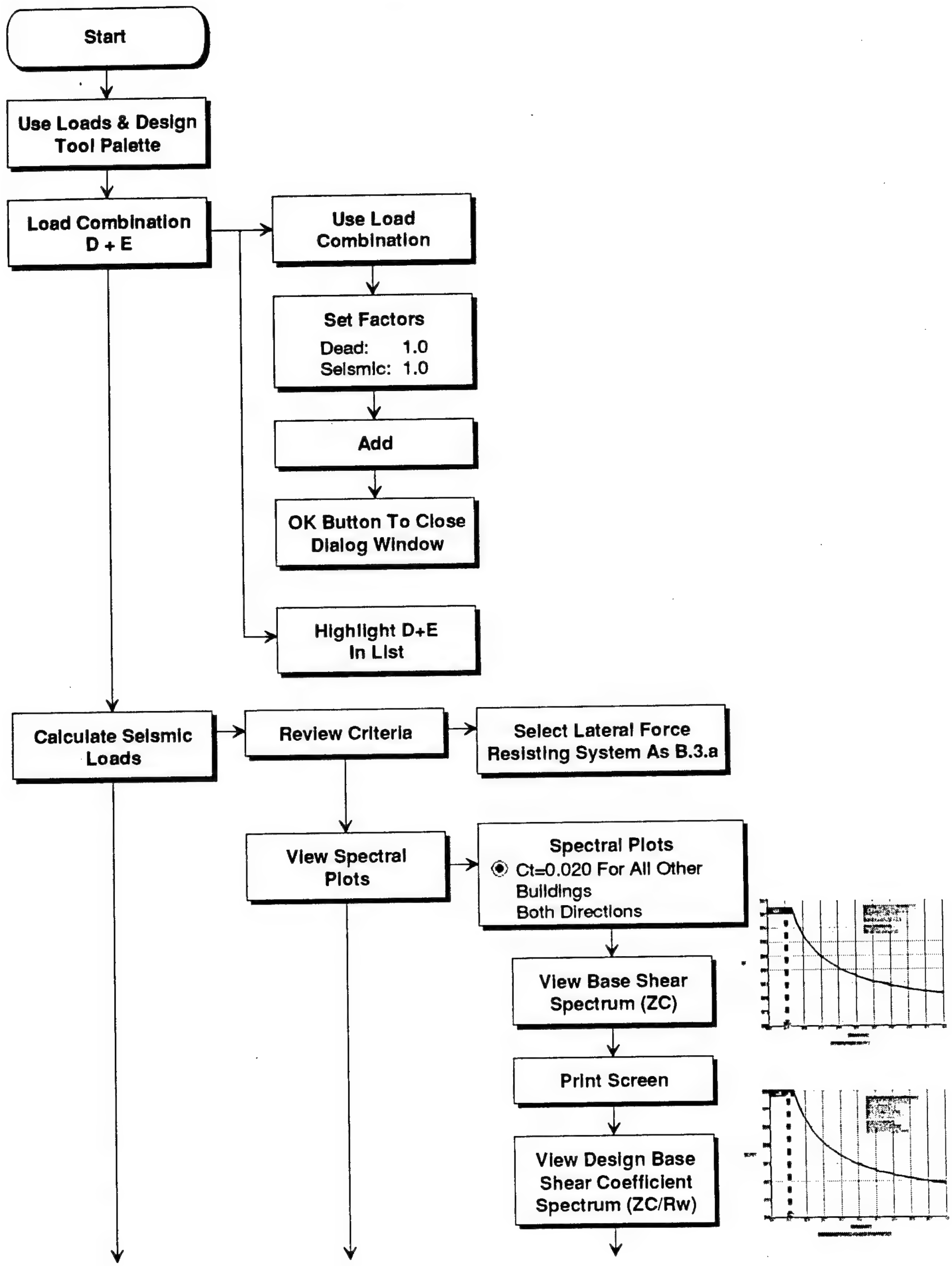
```
Assumptions used:
   Em = 432000 ksf  Ev = 0.4*Em = 172800 ksf
   Deflections calculated by applying a 1000 k load.
   Interstory shear wall deflection is calculated based on cantilever
      action. Deflection at a level is obtained by summing each story's
      cantilever deflection from grade.
   Deflection = P*(h^3)/(3*Em*I)+(1.2*P*h)/(A*Ev)
      h = floor to floor height
```

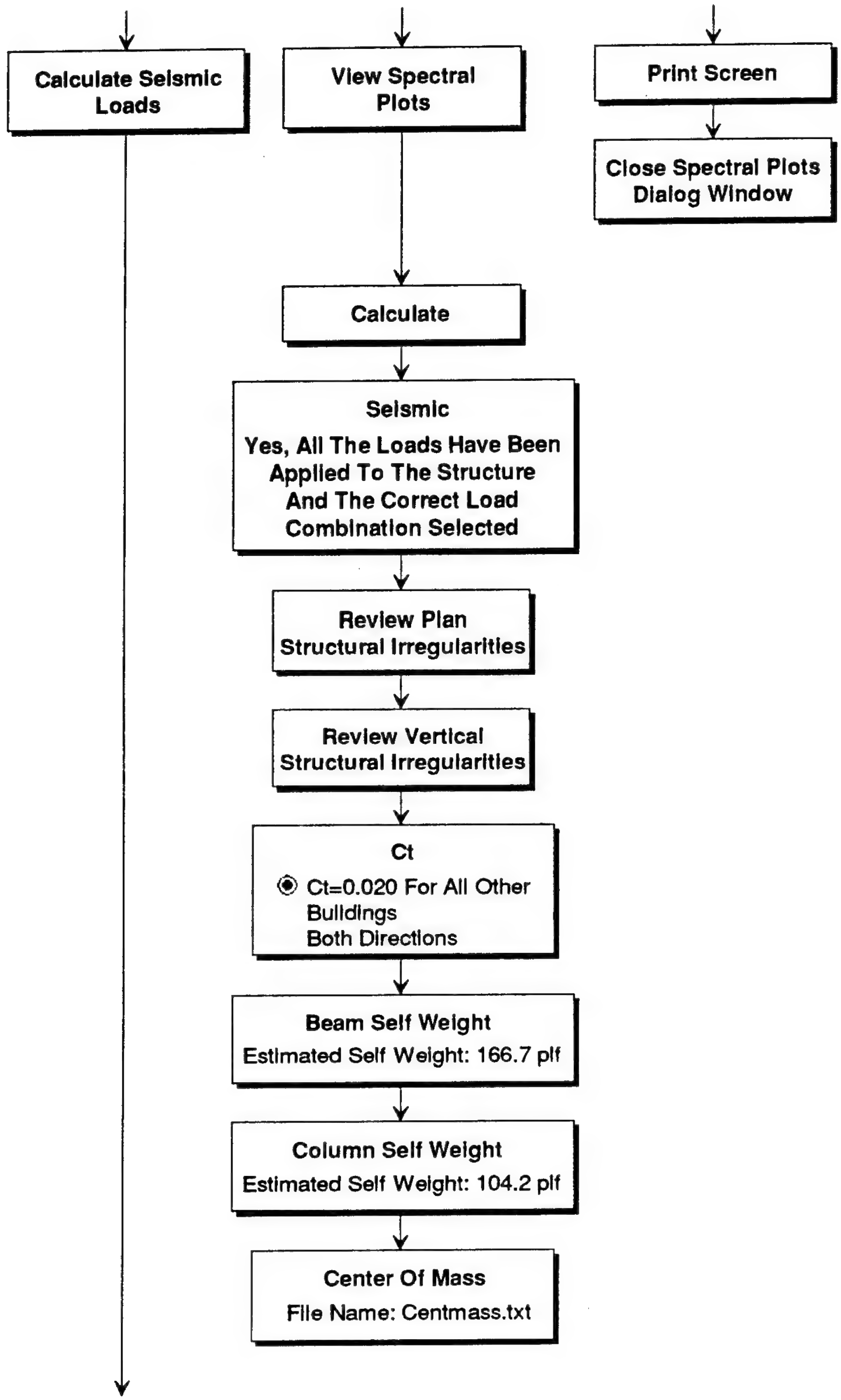
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	11.793	44.2	521.696	23079.574	0.00360
NS-2	14.0	14.046	3.8	52.819	198.625	0.00036
NS-3	14.0	11.793	39.8	468.877	18642.790	0.00324
EW-1	14.0	39.981	35.9	1434.400	51461.513	0.00990
EW-2	14.0	39.957	35.9	1434.400	51493.443	0.00990
Sum					144875.945	

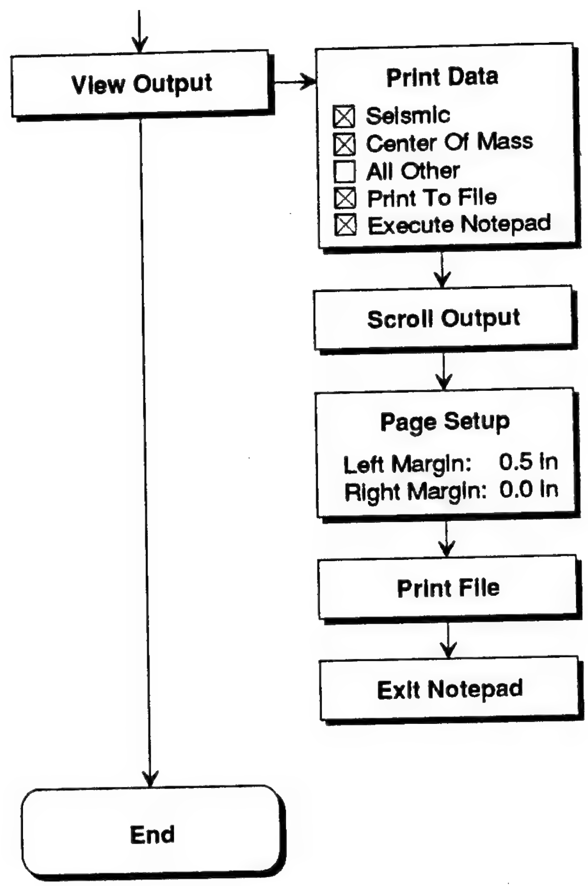
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	28.0	5.896	25.6	150.730	3853.186	0.00477
NS-2	28.0	6.870	21.9	150.730	3307.112	0.00477
EW-1	28.0	10.063	34.0	341.790	11609.457	0.01082
EW-2	28.0	9.105	37.5	341.790	12829.972	0.01082
Sum					31599.727	

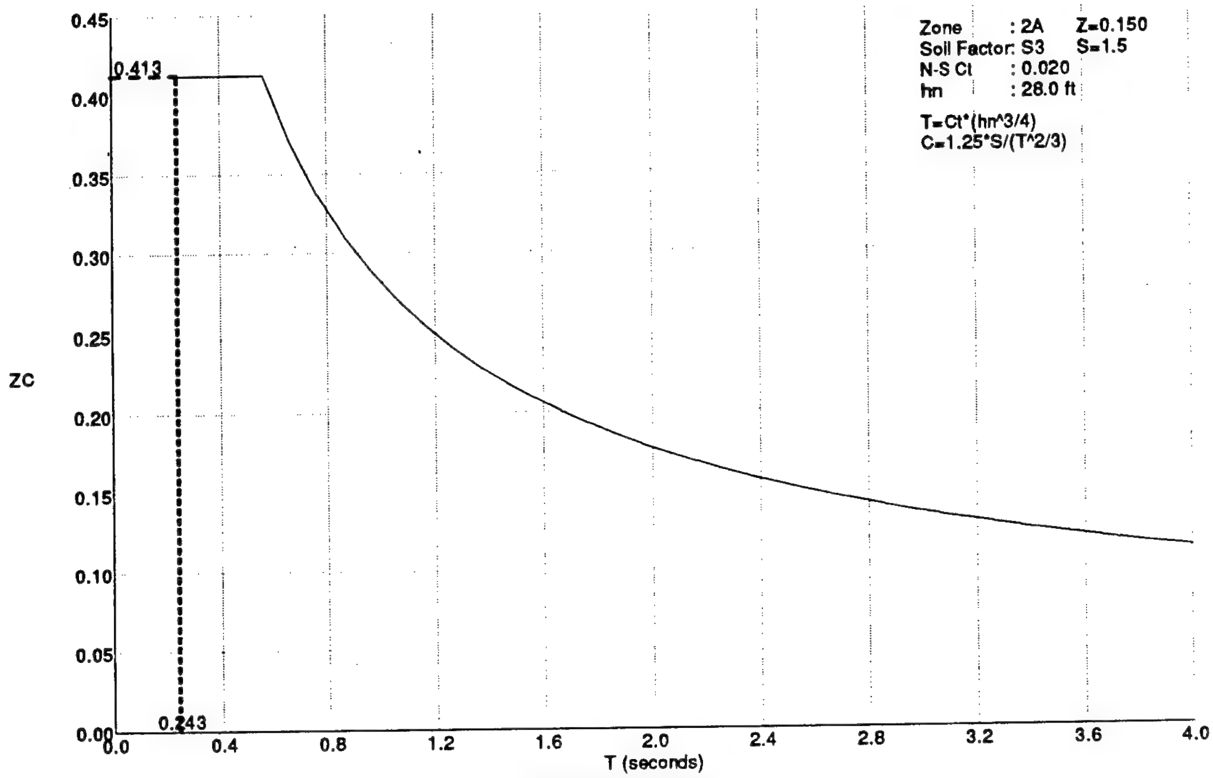
```
Shear distribution       : Fv = V*R/sum(R)
Torsional moment         : Mt = V*e
Torsional component      : Ft = Mt*R*dx/sum(R*dx*dx)
Total shear to element: Ftotal = Fv + Ft
```

Seismic Loads

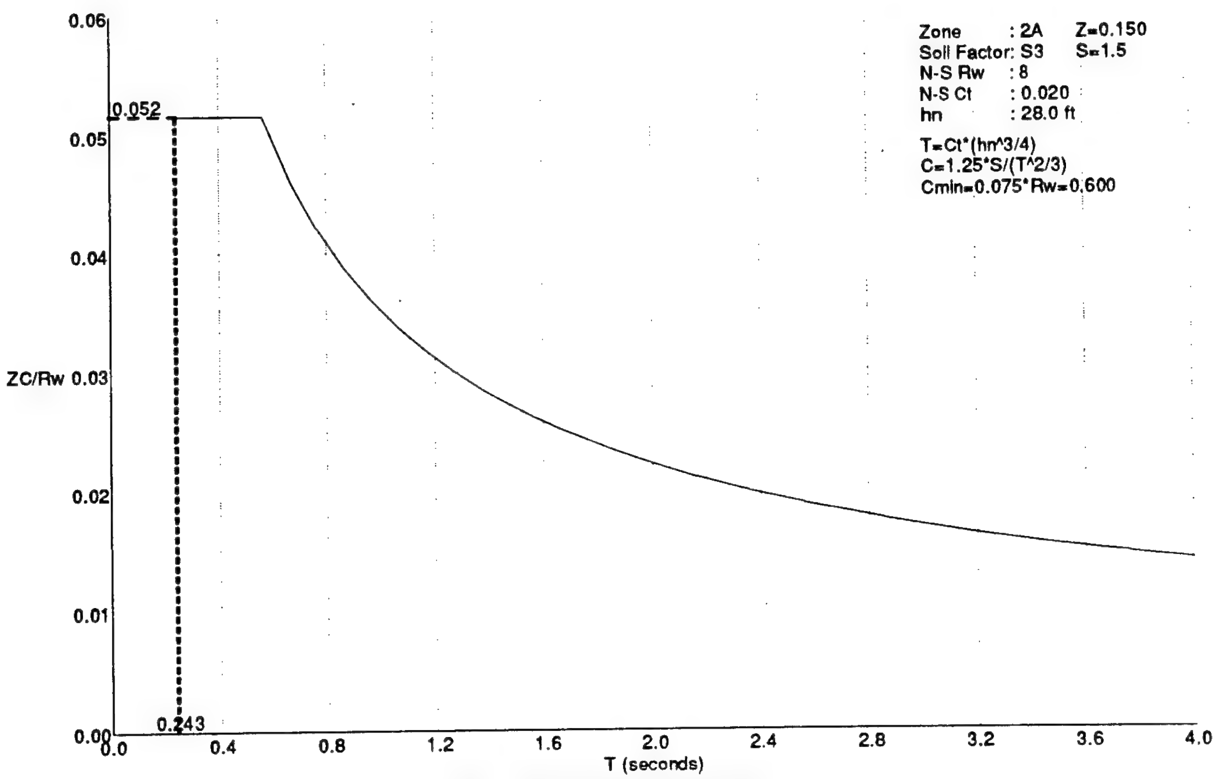



Calculate Seismic Loads
View Spectral Plots
Print Screen
Close Spectral Plots Dialog Window
Calculate
Seismic
Yes, All The Loads Have Been Applied To The Structure And The Correct Load Combination Selected
Review Plan Structural Irregularities
Review Vertical Structural Irregularities
Ct
Ct=0.020 For All Other Buildings
Both Directions
Beam Self Weight
Estimated Self Weight: 166.7 plf
Column Self Weight
Estimated Self Weight: 104.2 plf
Center Of Mass
File Name: Centmass.txt


View Output
Print Data
☒ Seismic
☒ Center Of Mass
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



N-S Base Shear Spectrum



N-S Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme C
Location     : Radford AAP
Seismic Code: TM 5-809-10 1992
Time         : Thu Sep 01, 1994  4:06 PM

***************************** Seismic Analysis *****************************

 3. Upper Roof                                  :     320.9 k
 2. Second Floor/Lower Roof                     :     637.5 k
---------------------------------------------------------------
Total Building Weight (W)                       :     958.4 k

****************************** N - S and E - W *****************************

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: B3a: Rw = 8
Ct = 0.020
hn = 28.0 ft
T = Ct*hn^3/4 = 0.243 sec
C = 1.25*S/T^2/3 = 4.82 > 2.75
C = 2.75
C/Rw = 0.344 > 0.075
W = 958.4 k
V = Z*I*C*W/Rw
+-------------------------+
|       V = 49.4 k        |
+-------------------------+

T < 0.7 sec
+-------------------------+
|       Ft = 0.0 k        |
+-------------------------+

+-------------------------+
|     V-Ft = 49.4 k       |
+-------------------------+
```

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	w*h (kft)	w*h/ sum(w*h)	F (k)	sum(F) V (k)
						Ft =	0.0	
3	28.0		321		8985	0.502	24.8	
		14.0		321				24.8
2	14.0		638		8926	0.498	24.6	
		14.0		958				49.4
1	0.0							
Sum			958		17911	1.000	49.4	

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)	Ft+sum(F)/ sum(w)
3	28.0		321					
		14.0		321	24.8	347		0.077
2	14.0		638				347	
		14.0		958	49.4	692		0.052
1	0.0						1039	
Sum			958			1039		

Project : Office Building - Scheme C
Location : Radford AAP
Time : Thu Sep 01, 1994 4:06 PM

***************************** Center Of Mass *****************************

Upper Roof -- 28.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Shear Wall	1.6	72.8	114.7	36.8	58.0
Shear Wall	1.6	60.8	95.8	48.8	76.9
Shear Wall	1.6	36.8	58.0	0.8	1.3
Shear Wall	1.6	0.8	1.3	36.8	58.0
Exterior Wall	11.1	12.8	142.0	0.8	9.2
Exterior Wall	11.1	0.8	9.2	12.8	142.0
Exterior Wall	11.1	60.8	673.3	0.8	9.2
Exterior Wall	11.1	72.8	806.1	12.8	142.0
Exterior Wall	22.1	24.8	549.7	48.8	1081.0
Upper Roof	192.5	36.8	7091.7	24.8	4781.3
Beam Self Weight	52.0	36.8	1915.7	24.8	1291.6
Column Self Weight	3.6	36.8	134.3	24.8	90.6
Sum	320.9		11591.9		7741.1

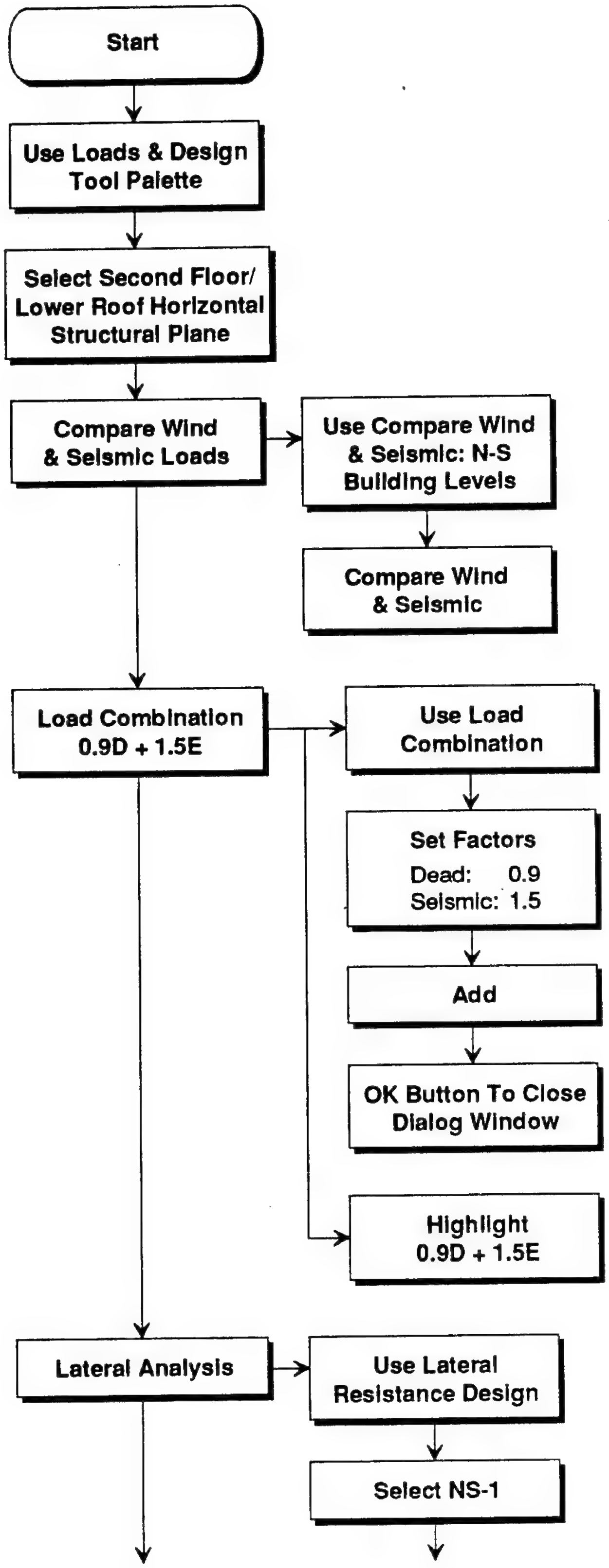
N-S Center Of Mass: 36.12 ft
E-W Center Of Mass: 24.12 ft

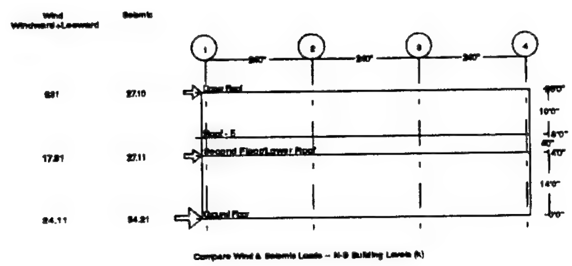
Second Floor/Lower Roof -- 14.00 ft

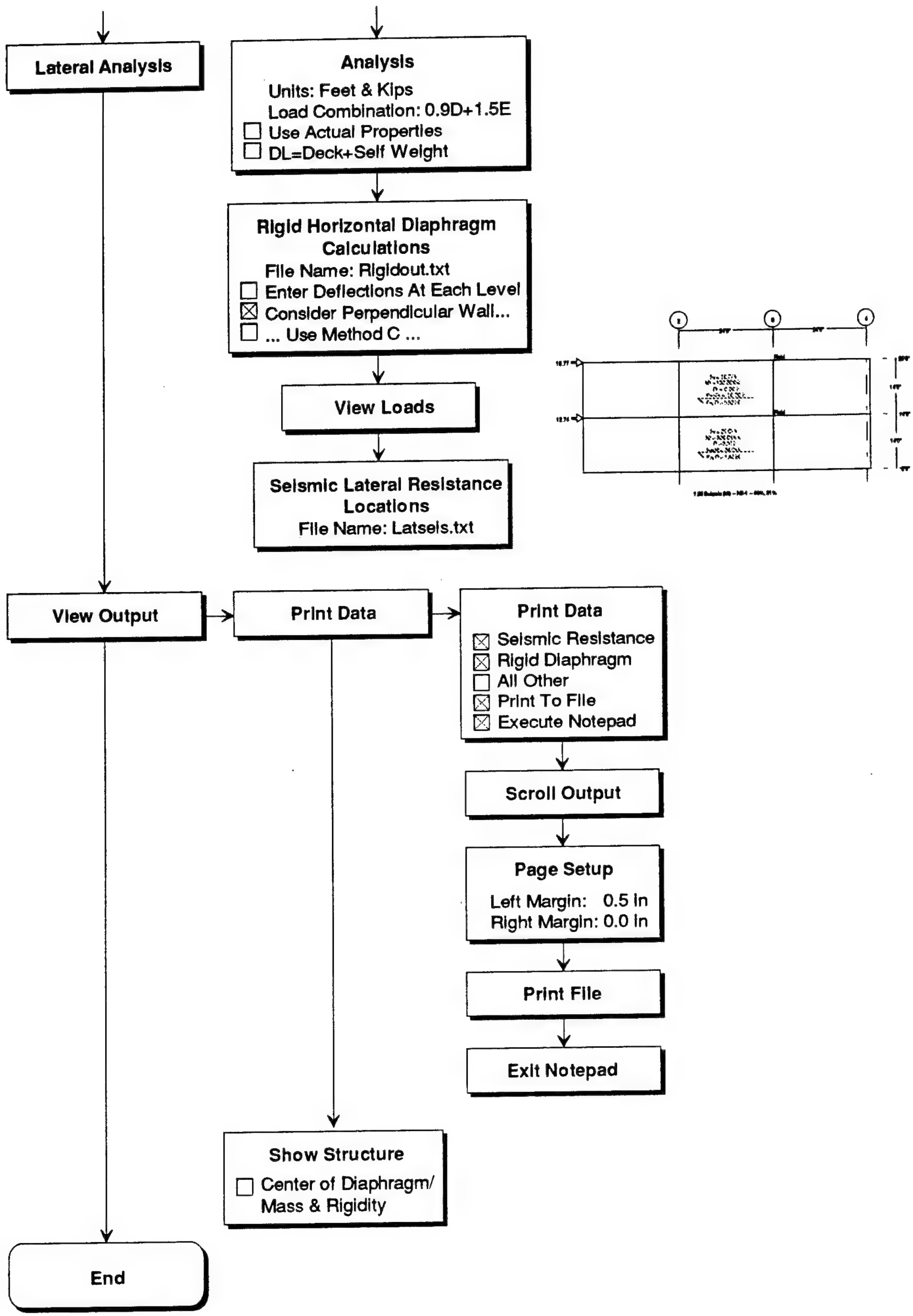
Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Shear Wall	3.1	72.8	229.4	36.8	116.0
Shear Wall	3.1	60.8	191.6	48.8	153.8
Shear Wall	3.1	36.8	116.0	0.8	2.6
Shear Wall	3.1	0.8	2.6	36.8	116.0
Second Floor	89.0	12.8	1142.1	24.8	2210.1
Second Floor	74.2	36.8	2731.7	28.8	2138.4
Second Floor	89.0	60.8	5413.9	24.8	2210.1
Lower Roof	111.3	36.8	4098.6	66.8	7436.8
Exterior Wall	22.1	12.8	284.1	0.8	18.4
Exterior Wall	22.1	0.8	18.4	12.8	284.1
Exterior Wall	22.1	60.8	1346.6	0.8	18.4
Exterior Wall	22.1	72.8	1612.2	12.8	284.1
Exterior Wall	22.1	24.8	549.7	48.8	1081.0
Parapet	5.9	12.8	76.3	84.8	504.3
Parapet	5.9	60.8	361.6	84.8	504.3
Shear Wall	18.6	72.8	1352.0	66.8	1240.6
Shear Wall	18.6	0.8	15.5	66.8	1240.6
Shear Wall	12.4	36.8	455.8	84.8	1049.8
Beam Self Weight	60.0	36.8	2210.4	36.2	2174.1
Column Self Weight	3.6	36.8	134.3	36.2	132.1
Exterior Wall	11.1	12.8	142.0	84.8	938.9
Exterior Wall	11.1	60.8	673.3	84.8	938.9
Column Self Weight	3.6	36.8	134.3	24.8	90.6
Sum	637.5		23292.7		24884.1

N-S Center Of Mass: 36.54 ft
E-W Center Of Mass: 39.03 ft

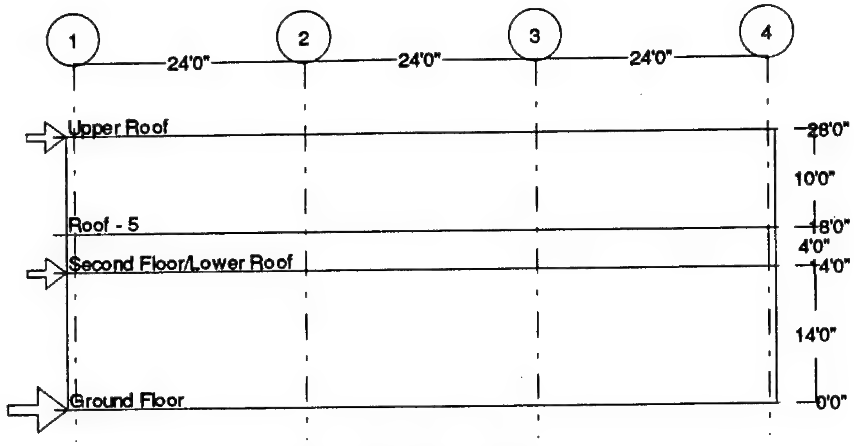
Seismic Lateral Analysis



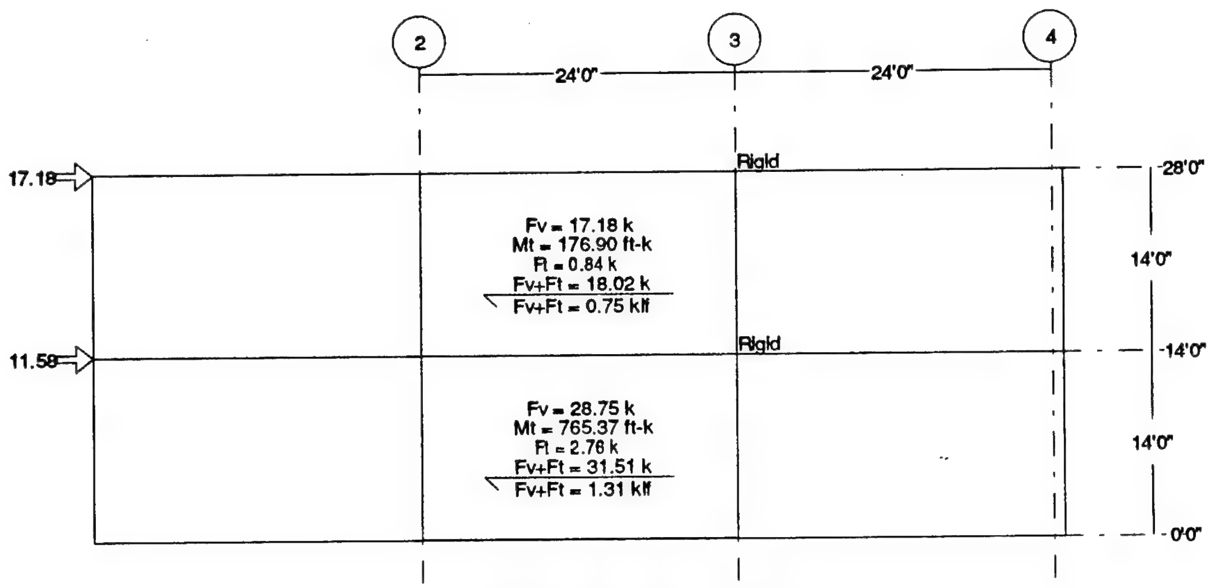



Lateral Analysis
Analysis
Units: Feet & Kips
Load Combination: 0.9D+1.5E
Use Actual Properties
DL=Deck+Self Weight
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
Enter Deflections At Each Level
Consider Perpendicular Wall...
... Use Method C ...
View Loads
Seismic Lateral Resistance Locations
File Name: Latseis.txt
View Output
Print Data
Print Data
Seismic Resistance
Rigid Diaphragm
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Show Structure
Center of Diaphragm/ Mass & Rigidity
End

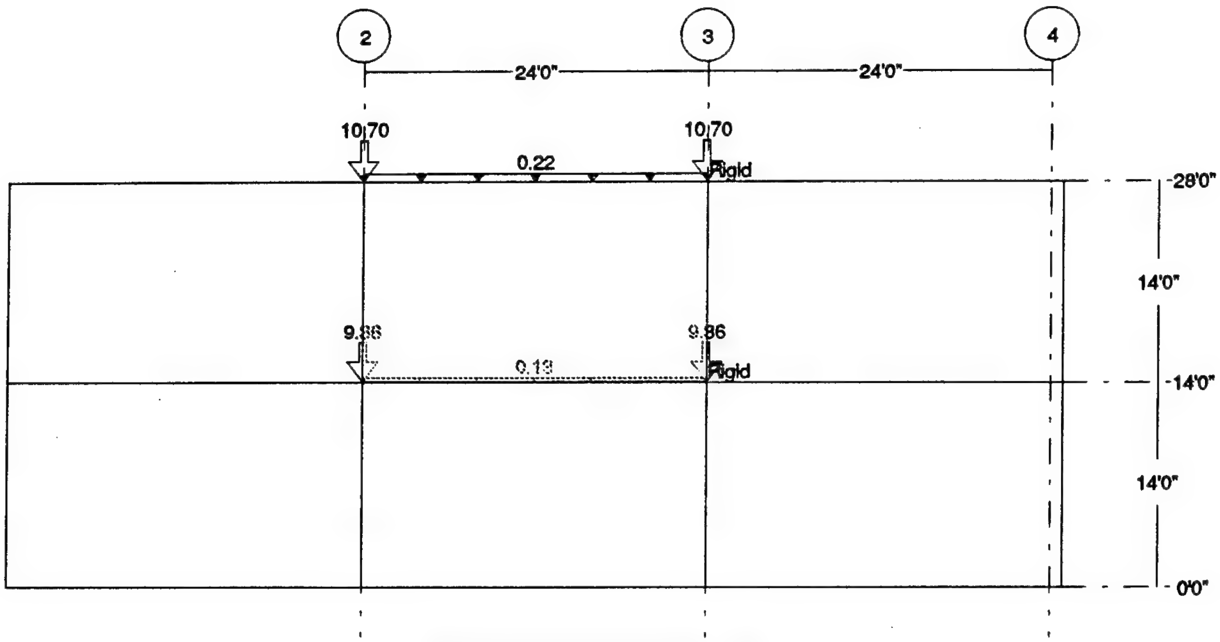
Wind Windward+Leeward	Seismic
6.31	24.79
17.81	24.63
24.11	49.42



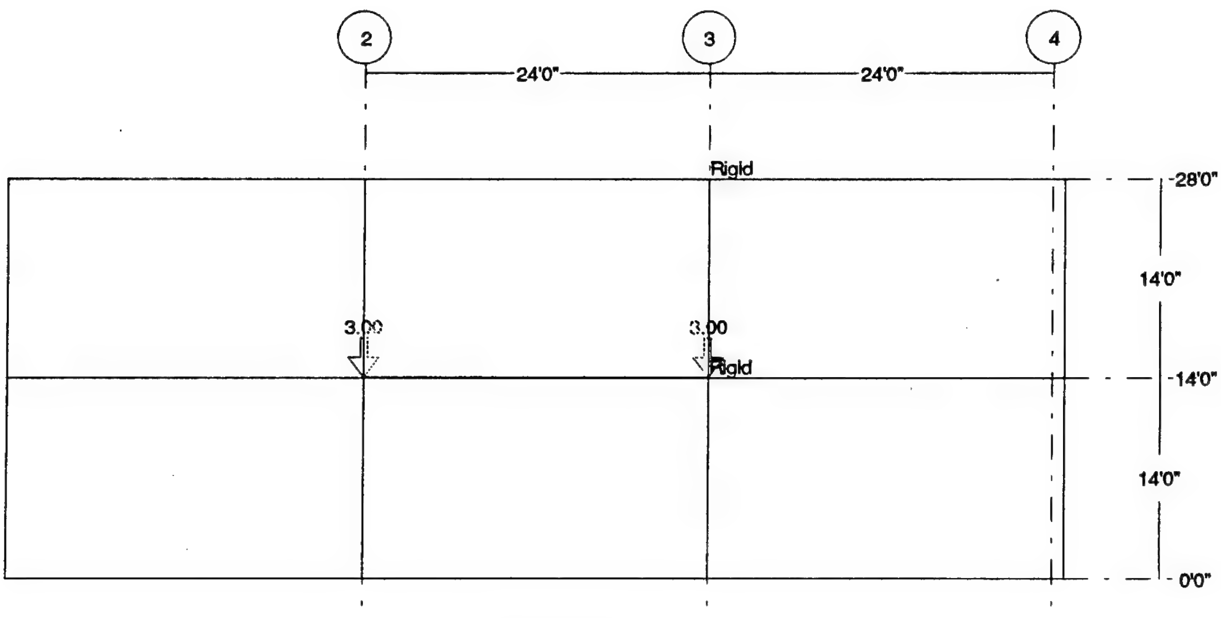
Compare Wind & Seismic Loads -- N-S Building Levels (k)



1.50 Seismic (klf) -- NS-1 – 46%, 31%



0.90 Superimposed Dead (klf) -- NS-1



0.90 Dead (klf) -- NS-1

```
Project       : Office Building - Scheme C
Location      : Radford AAP
Seismic Code: TM 5-809-10 1991
Time          : Sun Jan 26, 1992  8:16 PM
```

****************** Seismic Lateral Resistance Locations *******************

NS-1 -- 46%, 31%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		40.6			
		14.0		40.6	569	
2	14.0		40.7			569
		14.0		81.3	1138	
1	0.0					1707
Sum			81.3		1707	

NS-2 -- 54%, 37%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		40.6			
		14.0		40.6	569	
2	14.0		40.7			569
		14.0		81.3	1138	
1	0.0					1707
Sum			81.3		1707	

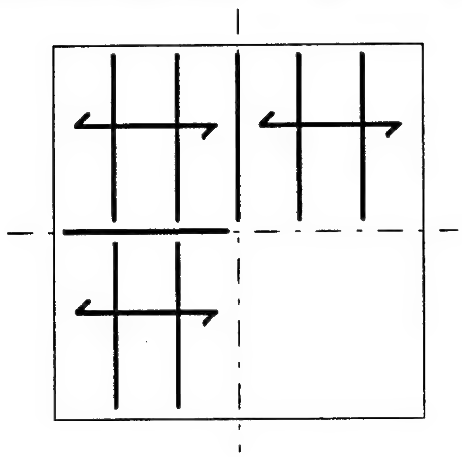
NS-3 -- F, 31%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		40.7			
		14.0		40.7	569	
1	0.0					569
Sum			40.7		569	

Quantity Take-Off Philosophy

3 Considerations

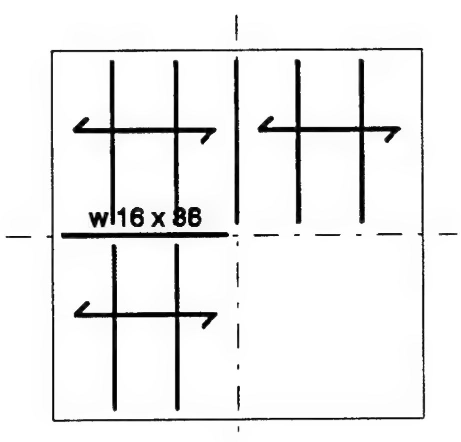
1. One typical interior bay (exterior side bay, corner bay)



2 bays
by
2 bays

2. One typical floor level and roof level

3. The entire building structural system



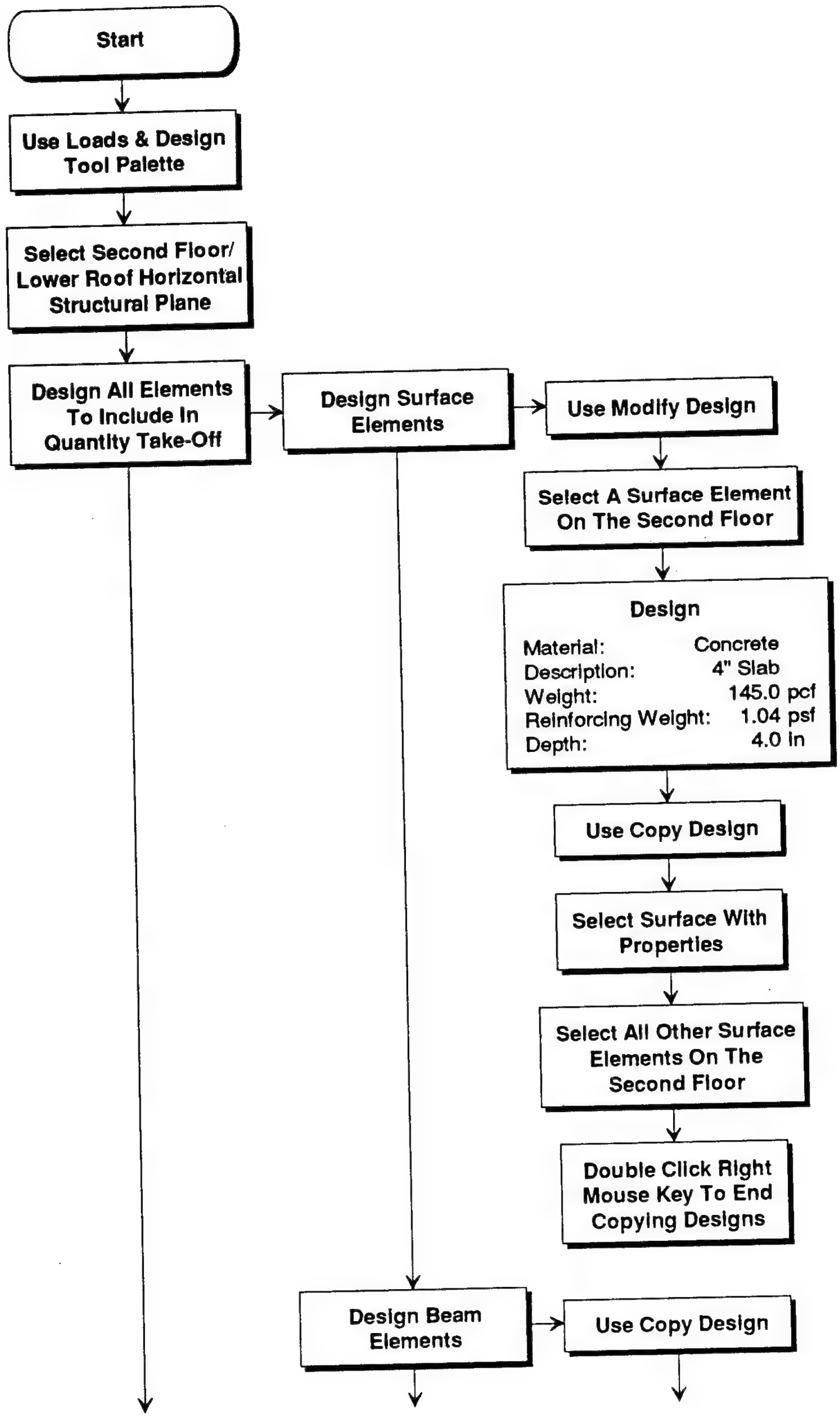
Estimated weights are not used
for quantity take-offs

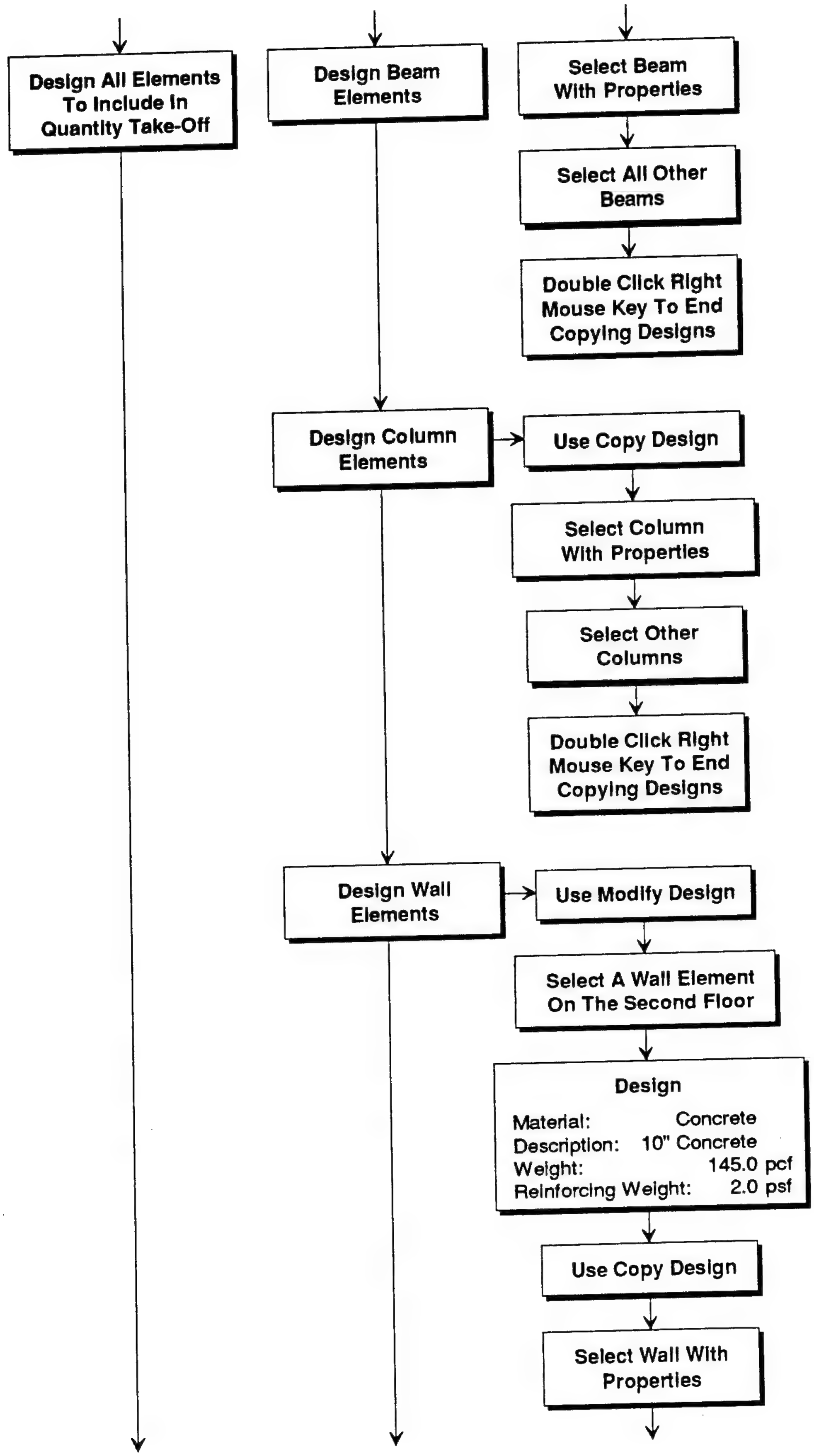
Elements designed by Excel
spreadsheets are used

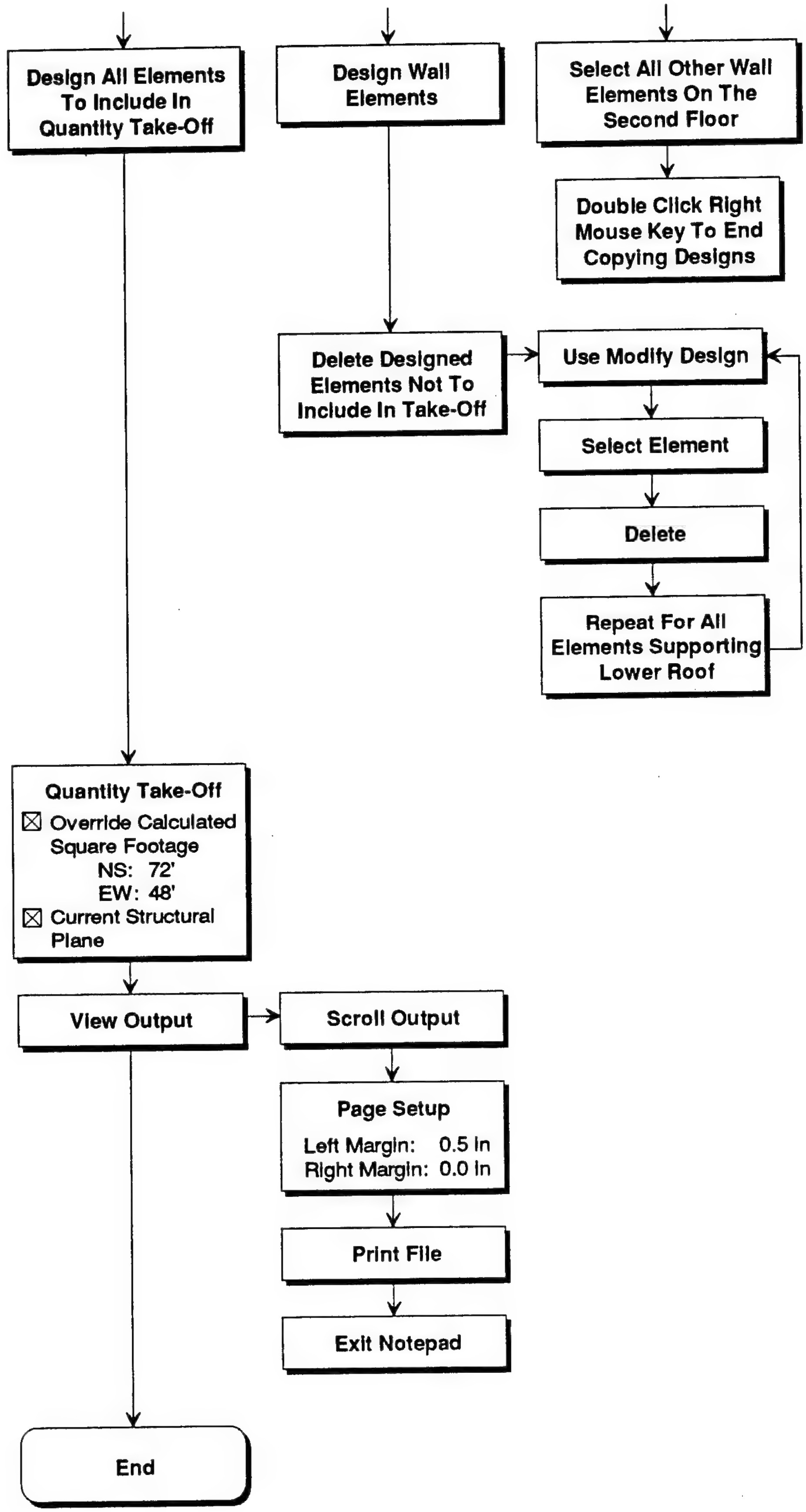
Use Modify Design and Copy Design
to manually enter element sizes

Calculated square footage
can be overridden

Quantity Take-Off




Design All Elements To Include In Quantity Take-Off
Design Beam Elements
Select Beam With Properties
Select All Other Beams
Double Click Right Mouse Key To End Copying Designs
Design Column Elements
Use Copy Design
Select Column With Properties
Select Other Columns
Double Click Right Mouse Key To End Copying Designs
Design Wall Elements
Use Modify Design
Select A Wall Element On The Second Floor
Design
Material: Concrete
Description: 10" Concrete
Weight: 145.0 pcf
Reinforcing Weight: 2.0 psf
Use Copy Design
Select Wall With Properties


Design All Elements To Include In Quantity Take-Off
Design Wall Elements
Select All Other Wall Elements On The Second Floor
Double Click Right Mouse Key To End Copying Designs
Delete Designed Elements Not To Include In Take-Off
Use Modify Design
Select Element
Delete
Repeat For All Elements Supporting Lower Roof
Quantity Take-Off
☒ Override Calculated Square Footage
NS: 72'
EW: 48'
☒ Current Structural Plane
View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Project : Office Building - Scheme C
Location : Radford AAP
Time : Sun Jan 26, 1992 8:20 PM

**************************** Quantity Take-off ****************************

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

CONCRETE: Narrowly Spaced Elements

Description	Area (sqin)	Length (ft)	Conc Weight (pcf)	Conc Weight (plf)	Weight/Element Conc (lbs)	Weight/Element Reinf (lbs)	No.	Total Weight Conc (lbs)	Total Weight Reinf (lbs)
	0	24.0	0	0.0	0	0.0	24	0	0
Sum								0	0

Concrete Cubic Yards : 0.0
Weight Per Square Foot : 0.0 psf
Reinforcing Total Weight: 0.0 tons
Weight Per Square Foot : 0.0 psf

CONCRETE: Widely Spaced Elements

Description	Area (sqin)	Length (ft)	Conc Weight (pcf)	Conc Weight (plf)	Weight/Element Conc (lbs)	Weight/Element Reinf (lbs)	No.	Total Weight Conc (lbs)	Total Weight Reinf (lbs)
10 x 16	160	24.0	145	161.1	3867	360.0	25	96667	9000
	0	24.0	0	0.0	0	0.0	2	0	0
Sum								96667	9000

Concrete Cubic Yards : 24.7
Weight Per Square Foot : 28.0 psf
Reinforcing Total Weight: 4.5 tons
Weight Per Square Foot : 2.6 psf

CONCRETE: Surface Elements

Description	Depth (in)	Area (sqft)	Conc Weight (pcf)	Conc Weight (psf)	Reinf Weight (psf)	Total Weight Conc (lbs)	Total Weight Reinf (lbs)
4" Slab	4.0	2880	145.0	48.3	1.0	139200	2995
4" Slab	4.0	384	145.0	48.3	1.0	18560	399
	0.0	2592	0.0	0.0	0.0	0	0
Sum						157760	3395

Concrete Cubic Yards : 40.3
Reinforcing Total Weight: 1.7 tons

CONCRETE: Column Elements

Description	Area (sqin)	Length (ft)	Conc Weight (pcf)	Conc Weight (plf)	Weight/Element Conc (lbs)	Weight/Element Reinf (lbs)	No.	Total Weight Conc (lbs)	Total Weight Reinf (lbs)
11 x 11	121	14.0	145	121.8	1706	112.0	5	8529	560
Sum								8529	560

Concrete Cubic Yards : 2.2
Weight Per Square Foot : 2.5 psf
Reinforcing Total Weight: 0.3 tons
Weight Per Square Foot : 0.2 psf

CONCRETE: Wall Elements

Description	Width (in)	Length (ft)	Height (ft)	Surf Area (sqft)	Conc Weight (pcf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
10" Concrete	10	24.0	14.0	336	145	40600	4	162400
	10	36.0	14.0	504	0	0	2	0
	10	24.0	14.0	336	0	0	1	0
Sum								162400

Concrete Cubic Yards : 41.5

Description	Width (in)	Length (ft)	Height (ft)	Surf Area (sqft)	Reinf Weight (psf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
10" Concrete	10	24.0	14.0	336	2	672	4	2688
	10	36.0	14.0	504	0	0	2	0
	10	24.0	14.0	336	0	0	1	0
Sum								2688

Reinforcing Total Weight: 1.3 tons

Concluding Remarks

Schemes A, B and C were developed to permit exploration and instruction of the broadest possible range of CASM capabilities. The schemes should not be viewed as completely logical structural framing solutions to the given design parameters, nor as necessarily economical. Each of the three schemes contain a variety of elements, which if properly combined and interchanged might produce "real" schemes for consideration at a 35% review.

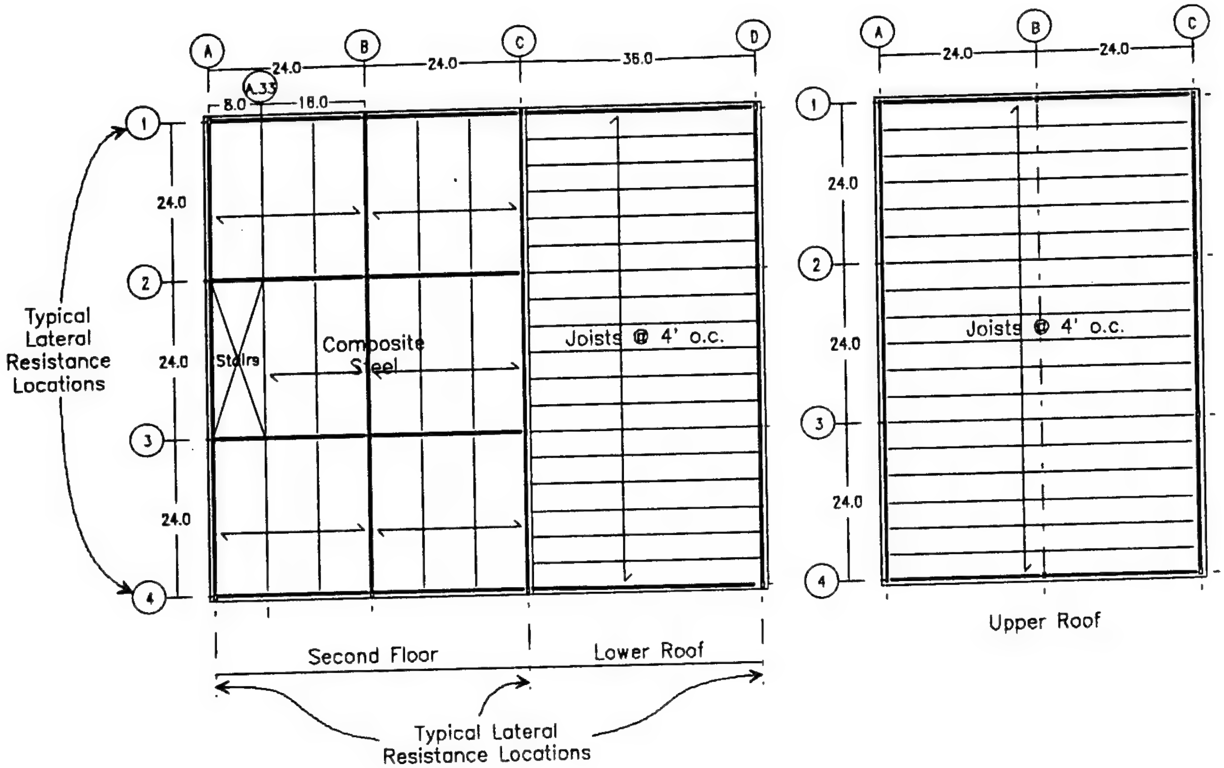
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the second floor.

A logical **steel framed beam/column** solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) as in scheme B. Both roofs would be sheathed with a metal roof deck without concrete and both would become flexible diaphragms. The second floor would be framed with composite steel beams as in scheme B and remain a rigid diaphragm. Two lateral load resistance system options could be compared. One scheme could include a moment resistant frame approach similar to scheme A, while a second approach might incorporate trussing similar to scheme B. The non-loadbearing exterior envelope is open to a variety of possibilities. The Architects will likely dictate the aesthetic expression. The foundation system would be a combination of isolated and linear spread footings.

A third logical solution would be a **masonry bearing wall** system to support the steel open-web joist roof planes described above. The second floor plane might be constructed of pre-cast pre-stressed hollow cored planks, which would also bear on the walls and a central steel girder line. Some of these walls could become shear walls for lateral load resistance. Thus the exterior envelope and the interior partition provide a structural function, eliminating costly moment connections and columns within the exterior wall layout. Footings are now all linear spread footings with only one isolated footing.

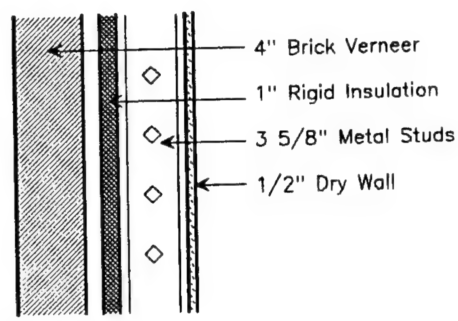
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

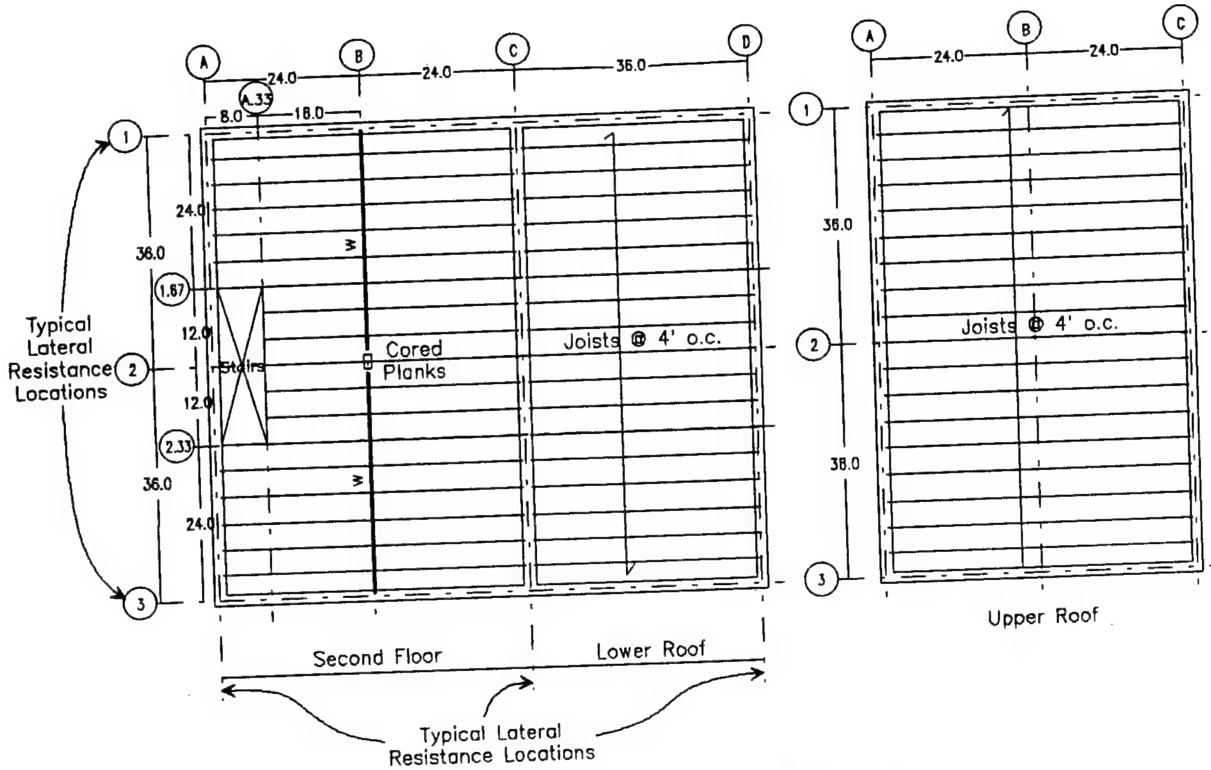
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

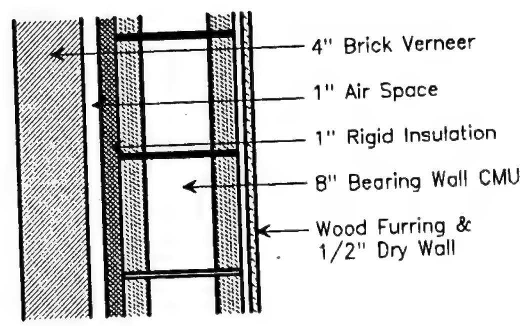
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC20503.

1.AGENCY USE ONLY *(Leave blank)*

2.REPORT DATE
June 1996

3.REPORT TYPE AND DATES COVERED
Report 5 of a series

4.TITLE AND SUBTITLE
Computer-Aided Structural Modeling (CASM), Version 6.00; Report 5: Scheme C

5.FUNDING NUMBERS
Contract No. DACA39-86-C-0024
Work Unit No. AT40-CA-001

6.AUTHOR(S)
David Wickersheimer, Carl Roth, Gene McDermott

7.PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Wickersheimer Engineers, Inc.,
821 South Neil Street, Champaign, IL 61820

8.PERFORMING ORGANIZATION REPORT NUMBER

9.SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers,
Washington, DC 20314-1000;
U.S. Army Engineer Waterways Experiment Station,
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

10.SPONSORING/MONITORING AGENCY REPORT NUMBER
Instruction Report
ITL-96-2

11.SUPPLEMENTARY NOTES
Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a.DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b.DISTRIBUTION CODE

13.ABSTRACT *(Maximum 200 words)*

The Computer-Aided Structural Modeling (CASM) computer program is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional (3-D) interactive graphics. CASM allows the structural engineer to quickly evaluate various framing alternatives in order to make more informed decisions in the initial structural evaluation process. The program was developed by the Information Technology Laboratory in conjunction with the Computer-Aided Structural Engineering (CASE) Project, Building Systems Task Group.

This release of the CASM is designed to aid the user with design criteria, building loads, and structural framing and design. The various parts of the program are summarized below.

a. Basic design criteria. The user can enter information directly or retrieve information from a user-definable database. The design criteria include information about the project, regional design information, and site-specific design information.

b. Building geometry. The user can assemble the building shape using 3-D primitives (cubes, prisms, spheres, cylinders, etc.) in an easy manner using pull-down menus, icons, and a mouse.

(Continued)

14.SUBJECT TERMS

Building systems	Preliminary structural design
Computer-Aided Structural Engineering (CASE)	Structural modeling
	3-Dimensional interactive graphics
Computer programs	3-Dimensional loads

15.NUMBER OF PAGES
192

16.PRICE CODE

17.SECURITY CLASSIFICATION OF REPORT	18.SECURITY CLASSIFICATION OF THIS PAGE	19.SECURITY CLASSIFICATION OF ABSTRACT	20.LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

13. (Concluded).

c. Dead and live loads. The user can select and construct dead and live loads from several user-definable menus of building materials and load conditions. These loads can then be applied to any desired area of the building volume.

d. Snow and wind loads. These loads are automatically calculated in 3-D using information from the basic design criteria database. Wind loads are also calculated for components and cladding and open roof structures. These loads are calculated in accordance with TM 5-809-1.

e. Seismic loads. These loads are calculated based on the equivalent static force method presented in TM 5-809-10.

f. Structural layout. The engineer can easily and rapidly experiment with various framing schemes inside the defined building volume. Beams, girders, joists, girts, columns, walls, and custom trusses are some of the structural elements that can be modeled.

g. Member analysis and preliminary sizing. The user can apply loads to the building geometry from a list of user-defined load cases. The shear, moment, and deflection of selected members may be calculated for various loading conditions (including pattern loads) and connectivity (including continuous beams). The design of a member is performed using a spreadsheet.

Data from the various investigated framing schemes can be edited and printed by CASM and used as justification in a design document.

This report describes the structural framing scheme for shear walls using monolithic concrete for a two-story portion, steel for the lower roof portion, and lateral load resistance.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980
	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Technical Report K-80-4	Documentation of Finite Element Analyses	
	Report 1: Longview Outlet Works Conduit	Dec 1980
	Report 2: Anchored Wall Monolith, Bay Springs Lock	Dec 1980
Technical Report K-80-5	Basic Pile Group Behavior	Dec 1980
Instruction Report K-81-2	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CSHTWAL)	
	Report 1: Computational Processes	Feb 1981
	Report 2: Interactive Graphics Options	Mar 1981
Instruction Report K-81-3	Validation Report: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Feb 1981
Instruction Report K-81-4	User's Guide: Computer Program for Design and Analysis of Cast-in-Place Tunnel Linings (NEWTUN)	Mar 1981
Instruction Report K-81-6	User's Guide: Computer Program for Optimum Nonlinear Dynamic Design of Reinforced Concrete Slabs Under Blast Loading (CBARCS)	Mar 1981
Instruction Report K-81-7	User's Guide: Computer Program for Design or Investigation of Orthogonal Culverts (CORTCUL)	Mar 1981
Instruction Report K-81-9	User's Guide: Computer Program for Three-Dimensional Analysis of Building Systems (CTABS80)	Aug 1981
Technical Report K-81-2	Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems	Sep 1981
Instruction Report K-82-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Jun 1982

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Instruction Report K-82-7	User's Guide: Computer Program for Bearing Capacity Analysis of Shallow Foundations (CBEAR)	Jun 1982
Instruction Report K-83-1	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Jan 1983
Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
Technical Report K-83-4	Case Study of Six Major General-Purpose Finite Element Programs	Oct 1983
Instruction Report K-84-2	User's Guide: Computer Program for Optimum Dynamic Design of Nonlinear Metal Plates Under Blast Loading (CSDOOR)	Jan 1984
Instruction Report K-84-7	User's Guide: Computer Program for Determining Induced Stresses and Consolidation Settlements (CSETT)	Aug 1984
Instruction Report K-84-8	Seepage Analysis of Confined Flow Problems by the Method of Fragments (CFRAG)	Sep 1984
Instruction Report K-84-11	User's Guide for Computer Program CGFAG, Concrete General Flexure Analysis with Graphics	Sep 1984
Technical Report K-84-3	Computer-Aided Drafting and Design for Corps Structural Engineers	Oct 1984
Technical Report ATC-86-5	Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II	Jun 1986
Technical Report ITL-87-2	A Case Committee Study of Finite Element Analysis of Concrete Flat Slabs	Jan 1987
Instruction Report ITL-87-1	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame Structures (CUFRAM)	Apr 1987
Instruction Report ITL-87-2	User's Guide: For Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-83	May 1987
Technical Report ITL-87-6	Finite-Element Method Package for Solving Steady-State Seepage Problems	May 1987
Instruction Report ITL-87-3	User's Guide: A Three Dimensional Stability Analysis/Design Program (3DSAD) Module	Jun 1987
	Report 1: Revision 1: General Geometry	Jun 1987
	Report 2: General Loads Module	Sep 1989
	Report 6: Free-Body Module	Sep 1989

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Instruction Report ITL-87-4	User's Guide: 2-D Frame Analysis Link Program (LINK2D)	Jun 1987
Technical Report ITL-87-4	Finite Element Studies of a Horizontally Framed Miter Gate Report 1: Initial and Refined Finite Element Models (Phases A, B, and C), Volumes I and II Report 2: Simplified Frame Model (Phase D) Report 3: Alternate Configuration Miter Gate Finite Element Studies–Open Section Report 4: Alternate Configuration Miter Gate Finite Element Studies–Closed Sections Report 5: Alternate Configuration Miter Gate Finite Element Studies–Additional Closed Sections Report 6: Elastic Buckling of Girders in Horizontally Framed Miter Gates Report 7: Application and Summary	Aug 1987
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume I, User's Manual	Aug 1987
Instruction Report ITL-87-5	Sliding Stability of Concrete Structures (CSLIDE)	Oct 1987
Instruction Report ITL-87-6	Criteria Specifications for and Validation of a Computer Program for the Design or Investigation of Horizontally Framed Miter Gates (CMITER)	Dec 1987
Technical Report ITL-87-8	Procedure for Static Analysis of Gravity Dams Using the Finite Element Method – Phase 1a	Jan 1988
Instruction Report ITL-88-1	User's Guide: Computer Program for Analysis of Planar Grid Structures (CGRID)	Feb 1988
Technical Report ITL-88-1	Development of Design Formulas for Ribbed Mat Foundations on Expansive Soils	Apr 1988
Technical Report ITL-88-2	User's Guide: Pile Group Graphics Display (CPGG) Post-processor to CPGA Program	Apr 1988
Instruction Report ITL-88-2	User's Guide for Design and Investigation of Horizontally Framed Miter Gates (CMITER)	Jun 1988
Instruction Report ITL-88-4	User's Guide for Revised Computer Program to Calculate Shear, Moment, and Thrust (CSMT)	Sep 1988
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume II, Theory	Feb 1989
Technical Report ITL-89-3	User's Guide: Pile Group Analysis (CPGA) Computer Group	Jul 1989
Technical Report ITL-89-4	CBASIN–Structural Design of Saint Anthony Falls Stilling Basins According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0098	Aug 1989

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Technical Report ITL-89-5	CCHAN–Structural Design of Rectangular Channels According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0097	Aug 1989
Technical Report ITL-89-6	The Response-Spectrum Dynamic Analysis of Gravity Dams Using the Finite Element Method; Phase II	Aug 1989
Contract Report ITL-89-1	State of the Art on Expert Systems Applications in Design, Construction, and Maintenance of Structures	Sep 1989
Instruction Report ITL-90-1	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CWALSHT)	Feb 1990
Technical Report ITL-90-3	Investigation and Design of U-Frame Structures Using Program CUFRBC Volume A: Program Criteria and Documentation Volume B: User's Guide for Basins Volume C: User's Guide for Channels	May 1990
Instruction Report ITL-90-6	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame or W-Frame Structures (CWFRAM)	Sep 1990
Instruction Report ITL-90-2	User's Guide: Pile Group–Concrete Pile Analysis Program (CPGC) Preprocessor to CPGA Program	Jun 1990
Technical Report ITL-91-3	Application of Finite Element, Grid Generation, and Scientific Visualization Techniques to 2-D and 3-D Seepage and Groundwater Modeling	Sep 1990
Instruction Report ITL-91-1	User's Guide: Computer Program for Design and Analysis of Sheet-Pile Walls by Classical Methods (CWALSHT) Including Rowe's Moment Reduction	Oct 1991
Instruction Report ITL-87-2 (Revised)	User's Guide for Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-89	Mar 1992
Technical Report ITL-92-2	Finite Element Modeling of Welded Thick Plates for Bonneville Navigation Lock	May 1992
Technical Report ITL-92-4	Introduction to the Computation of Response Spectrum for Earthquake Loading	Jun 1992
Instruction Report ITL-92-3	Concept Design Example, Computer Aided Structural Modeling (CASM) Report 1: Scheme A Report 2: Scheme B Report 3: Scheme C	 Jun 1992 Jun 1992 Jun 1992
Instruction Report ITL-92-4	User's Guide: Computer-Aided Structural Modeling (CASM) -Version 3.00	Apr 1992
Instruction Report ITL-92-5	Tutorial Guide: Computer-Aided Structural Modeling (CASM) -Version 3.00	Apr 1992

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Contract Report ITL-92-1	Optimization of Steel Pile Foundations Using Optimality Criteria	Jun 1992
Technical Report ITL-92-7	Refined Stress Analysis of Melvin Price Locks and Dam	Sep 1992
Contract Report ITL-92-2	Knowledge-Based Expert System for Selection and Design of Retaining Structures	Sep 1992
Contract Report ITL-92-3	Evaluation of Thermal and Incremental Construction Effects for Monoliths AL-3 and AL-5 of the Melvin Price Locks and Dam	Sep 1992
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume IV, User's Manual	Nov 1992
Technical Report ITL-92-11	The Seismic Design of Waterfront Retaining Structures	Nov 1992
Technical Report ITL-92-12	Computer-Aided, Field-Verified Structural Evaluation	
	Report 1: Development of Computer Modeling Techniques for Miter Lock Gates	Nov 1992
	Report 2: Field Test and Analysis Correlation at John Hollis Bankhead Lock and Dam	Dec 1992
	Report 3: Field Test and Analysis Correlation of a Vertically Framed Miter Gate at Emsworth Lock and Dam	Dec 1993
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume III, Example Problems	Dec 1992
Technical Report ITL-93-1	Theoretical Manual for Analysis of Arch Dams	Jul 1993
Technical Report ITL-93-2	Steel Structures for Civil Works, General Considerations for Design and Rehabilitation	Aug 1993
Technical Report ITL-93-3	Soil-Structure Interaction Study of Red River Lock and Dam No. 1 Subjected to Sediment Loading	Sep 1993
Instruction Report ITL-93-3	User's Manual—ADAP, Graphics-Based Dam Analysis Program	Aug 1993
Instruction Report ITL-93-4	Load and Resistance Factor Design for Steel Miter Gates	Oct 1993
Technical Report ITL-94-2	User's Guide for the Incremental Construction, Soil-Structure Interaction Program SOILSTRUCT with Far-Field Boundary Elements	Mar 1994
Instruction Report ITL-94-1	Tutorial Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
Instruction Report ITL-94-2	User's Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
Technical Report ITL-94-4	Dynamics of Intake Towers and Other MDOF Structures Under Earthquake Loads: A Computer-Aided Approach	Jul 1994
Technical Report ITL-94-5	Procedure for Static Analysis of Gravity Dams Including Foundation Effects Using the Finite Element Method – Phase 1B	Jul 1994

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Concluded)

	Title	Date
Instruction Report ITL-94-5	User's Guide: Computer Program for Winkler Soil-Structure Interaction Analysis of Sheet-Pile Walls (CWALSSI)	Nov 1994
Instruction Report ITL-94-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Nov 1994
Instruction Report ITL-94-7	User's Guide to CTWALL – A Microcomputer Program for the Analysis of Retaining and Flood Walls	Dec 1994
Contract Report ITL-95-1	Comparison of Barge Impact Experimental and Finite Element Results for the Lower Miter Gate of Lock and Dam 26	Jun 1995
Technical Report ITL-95-5	Soil-Structure Interaction Parameters for Structured/Cemented Silts	Aug 1995
Instruction Report ITL-95-1	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITER-LRFD)	Aug 1995
Technical Report ITL-95-8	Constitutive Modeling of Concrete for Massive Concrete Structures, A Simplified Overview	Sep 1995
Instruction Report ITL-96-1	User's Guide: Computer Program for Two-Dimensional Dynamic Analysis of U-Frame or W-Frame Structures (CDWFRM)	Jun 1996
Instruction Report ITL-96-2	Computer-Aided Structural Modeling (CASM), Version 6.00 Report 1: Tutorial Guide Report 2: User's Guide Report 3: Scheme A Report 4: Scheme B Report 5: Scheme C	Jun 1996
Instruction Report ITL-96-	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITERW-LRFD) Windows Version	Jul 1996